FORECASTING OUTLAYS FOR THE AIR FORCE SYSTEMS SUPPORT DIVISION

THESIS

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THESIS

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Gary William Boulware

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ABSTRACT

This study was undertaken in response to the Air Force Logistics Command Comptroller's interest in improving outlay forecasts for the System Support Division (SSD) portion of the Air Force Stock Fund. The need to improve outlay forecasts is driven by the overall government need to manage outlays, due to the growing emphasis on controlling the annual deficit. The literature suggests improving outlay forecasting methods at the sub-appropriation level to begin the long-term task of managing outlays.

The information gathered on forecasting methods indicated that basic statistics, graphing, regression, and time-series techniques might provide the answer to improved outlay forecasts.

The best technique for forecasting SSD outlays in this paper was the decomposition time series technique Census II. Census II was able to forecast to within one percent or one million dollars of the actual SSD outlays for the 3rd Quarter of FY 88. This was a significant improvement from HQ AFLC's estimate, which was overstated by 33% or $27.4 million.

Recommendations included that the Census II and other time-series forecasting methods, such as Holt and Winters, be used to further test their ability to forecast SSD outlays as well as other appropriations.

FORECASTING OUTLAYS FOR THE AIR FORCE SYSTEM SUPPORT DIVISION

I. Introduction

General Issue

Any American who watches national news, reads a paper or a popular news magazine knows that the size of the national debt is a major concern. For many government leaders, this pressing issue has become a management problem as budget cuts reduce manpower, operating funds, and the scope of long-term projects. Outlays are the driving force behind the national debt and recent deficit reduction legislation. An outlay is the flow of cash from the US Treasury. Examples include pay to government employees, travel expenditures, or payments to contractors who have provided goods or services to the US Government. A major concern of the entire federal government is how to forecast outlays.

With the advent of deficit controlling legislation, forecasting outlays has come to the foreground of government financial management. Now, not only is an item's purchase price of concern, but also when in the future the payment will actually occur. This is due to the type of accounting

system used by the federal government--one based on limiting the dollar amount of items ordered or services requested but not controlling the timing of actual expenditures for the items or services. The actual payments or "outlays" may be made in the current fiscal year or some future year.

An oversimplified example of this is a million dollar contract made with a company to provide a number of aircraft parts. The government procurement officer must have a million dollars in authority in the current year (normally referred to as obligation authority) to enter into the contract. The aircraft parts however, may take six to twenty-four months to be produced and delivered. The contractor will only be paid as the parts are delivered. In this example, the outlay could occur in the current year, the following year, two years after the original contract is made, or any time in between.

Due to recent legislation enacted by Congress, the timing of the outlays has become important in limiting the annual deficit and moreover the national debt. Legislative actions now call for the management of outlays as well as obligation authority.

Background

This background information discusses the legislative actions taken to curb the national debt, and the problems of controlling the variables which drive the debt--most notably outlays. The national debt is the amount of money the

national treasury has borrowed in total to pay for goods and services in excess of revenue (money flowing into the treasury). The annual deficit is the amount that the treasury borrows to meet any given year's payments in excess of revenues. The sum of the annual deficits equals the total national debt. A surplus would occur if the amount of revenue exceeded the payments out of the national treasury. The terms annual deficit and national debt are often used interchangeably in literature as they directly affect each other.

Outlays are the actual expenditures of funds from the national treasury. When most government managers refer to "spending their money" by the end of the fiscal year, they are referring to obligating their money. An obligation occurs when an authorized agent of the government agrees to pay for goods and services, even if these are to be delivered and paid for at some time in the future.

In order to understand the significance of forecasting outlays, it is necessary to review debt reducing legislation, the persistence of the debt in spite of the legislative action, the reasons for this persistence, and the impact of the most current debt reducing legislative efforts on the need to forecast outlays.

Debt Reducing Legislation: FY 81-85. It appears most people have heard of Gramm-Rudman-Hollings, properly called Public Law 99-177, The 1985 Balanced Budget and Emergency Deficit Control Act. However, Gramm-Rudman-Hollings was not

the first legislative attempt to curb the growth of the national debt. Joseph C. Wakefield, in February of 1986, compiled the following list [24:32]:

Omnibus Budget Reconciliation Act of 1981
Omnibus Budget Reconciliation Act of 1982
Tax Equity and Responsibility Act of 1982
Omnibus Budget Reconciliation Act of 1983
Deficit Reduction Act of 1984

<u>Continued Growth of the Debt FY 81-85</u>. Despite the above listed legislation, Wakefield points out that the annual deficit actually continued to grow, enlarging the total national debt.

> The combined effect of these legislative actions was expected to increase receipts almost $150 billion, reduce outlays just over $180 billion, and reduce the deficit $330 billion over the fiscal year 1981-87 period...Despite these actions, the unified budget deficit increased substantially. In fiscal 1981, the deficit was $78.9 billion; in fiscal 1985, $212.3 billion [24:32].

The national debt during fiscal years 1981-1985 was also growing as measured by other economic thermometers. A frequent argument for acceptance of increases in the national debt was that the debt was growing proportionately with the total value of goods and services produced by the nation--the Gross National Product (GNP). However, the annual deficit increased from 2% of the GNP in fiscal year 1981 to 6.1% in fiscal year 1983 (23:54). Interest payments on the national debt rose from the historic trend of 1.6%, to 3.1% of the GNP in FY 84 (1:8). Projections made in FY 85 showed continued increases in the debt with respect to the GNP through 1989 (23:62).

Another argument was that as the economy recovered the deficit would fall in line with the GNP. However, due to the size and the structure of the deficits, "vigorous economic recovery" had only a moderate effect on the FY 84 deficit (23:54). In fact, nearly 40 percent of the total national debt occurred in FY 82-84 (23:61). A somewhat simplistic but still forceful example of the size of the national debt is that by FY 85 the debt rose to "$2.0 trillion and represents more than $7,000 for every man, woman and child in the nation" (22:467).

Factors Complicating Debt Reduction Efforts. There were many factors working against the deficit reduction legislation. The Reagan agenda was to build up defense, reduce taxes, and reduce the size of federally funded domestic programs. The first two agenda items were accomplished early in the Reagan administration, but reducing the size of domestic programs was very difficult (13:7). Also contributing to the size of the annual deficits were the high interest rates and slower than expected growth of the economy (13:7). By FY 85, the budget process became destabilized due to the growing procedural, policy and political constraints (16:84). The news media focused the national attention on the problem of the debt and Congress was really in the spotlight to fix the situation.

Gramm-Rudman-Hollings and the "Trigger Mechanism". It is with this background in mind that Congress enacted yet

another deficit control law--Gramm-Rudman-Hollings. However, this law differed from its predecessors because it established formal procedures for determining if a deficit was forecast for the entire federal government. The concept of requiring outlay forecasts is a significant step forward. However, the current accounting system does not lend itself to the level of accuracy desired (this point will be more fully developed later in this paper). If the appropriate parties could agree on the fact that forecasted outlays were in excess of the Gramm-Rudman-Hollings ceiling, the law detailed procedures for automatic budget reductions--called the "Trigger Mechanism."

Gramm-Rudman-Hollings provided for a "trigger mechanism" or automatic budget reduction if the forecasted outlays would cause the annual deficit to exceed the maximum targets established in the law. The maximum deficit levels in Gramm-Rudman-Hollings were $171.9 billion in FY 86; $144 billion in FY 87; $108 billion in FY 88; $72 billion in FY 89; $36 billion in FY 90; and no deficit in FY 91 (25:5). The Comptroller General would pull the trigger based on estimates of the current year's deficit overrun from the Office of Management and Budget (OMB) and the Congressional Budget Office (CBO). Pulling the trigger involves the Comptroller General reporting to the President the amount of budget reductions required to stay within the law. The President is then required to sequester (cancel budget

authority) to stay within the law (12:4-6). This quote addresses the philosophy behind the automatic cuts provision of the act:

> Congress was flatly unwilling to leave the control of this powerful machinery exclusively in the hands of the President or his Office of Management and Budget. Neither, however did Congress wish to face the politically difficult task of voting to pull the trigger, if it could be avoided [13:10].

The underlying idea behind the automatic reductions was to provide "such an unattractive alternative that Congress would reach deficit targets on their own" (16:87).

Impact on FY 86. Unfortunately, the unattractive alternative of automatic cuts was required in FY 86. The formula for allocating the cuts was very specific and quite complicated as some federal budget programs were exempt (such as Social Security) and other programs were subject to special rules or had maximum reductions specified. Figure 1 is a pie chart indicating the small percentage of the total budget subject to reductions. The majority of the pie was exempt from automatic budget reductions.

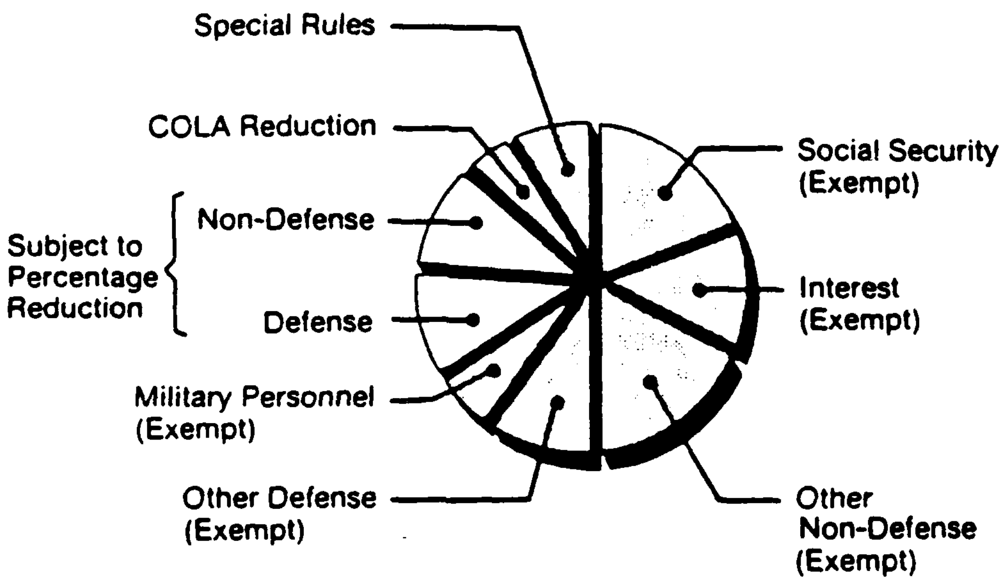

Figure 1. Programs Exempt from Automatic Budget Cuts
Source: (13:14)

This paragraph contains information from an article by Harry S. Havens concerning both the dollar amount of reduction and where the reduction occurred in FY 86 (12:5-7). Mr. Havens, the Assistant Comptroller General of the United States, was responsible for implementing Gramm-Rudman-Hollings. The total reduction required throughout the government was $11.7 billion. Gramm-Rudman-Hollings specified that half the total reduction would come from defense programs. Therefore, the defense portion was initially calculated as $5.85 billion; however, that amount was decreased $.497 billion due to a special rule applied to cost of living allowances for the retirement fund. The actual reduction for the Department of Defense (DOD) was $5.353 billion or 4.9 percent in future FY 86 outlays.

The problem is that the government controls obligation

authority, but not the timing of outlays as explained earlier. Therefore, the computed reduction in obligation authority was determined to be $14.1 billion with the intention of reducing outlays by the $5.353 billion in FY 86. Thus, a deficit reduction law finally did have an impact. But would Gramm-Rudman-Hollings have an impact in subsequent fiscal years?

Impact on FY 87-88. Charles W. Washington, an associate professor of public administration at George Washington University, had this to say about the impact of Gramm-Rudman-Hollings during the early stages of the FY 87 budget building process:

> The most striking and apparent fact from the President's proposed budget is that he has submitted a budget that will achieve levels of deficit reduction below the maximum set by Congress in the Balanced Budget Act of 1985...Based on the administration's economic assumptions and the cooperation of Congress, the President believes his proposed budget will produce a maximum deficit of $142 billion in FY 1987 [25:24].

As indicated above, the maximum deficit ceiling was $144 billion; therefore, at least there was an effort to remain within the Gramm-Rudman-Hollings requirements when building the budget.

The "cooperation of Congress" is a key phrase. The President's proposed budget projected three percent real growth for defense, increased privatization by selling government owned and operated businesses, and increased fees and charges for various government services. Further, the budget proposal suggested restructuring federal block

grants, and terminating 40 government expenses such as the Small Business Administration, general revenue sharing, postal and Amtrak subsidies, and the new GI Bill [25:21-22].

Gramm-Rudman-Hollings also had an effect on how Congress considered the FY 87 budget. The only amendments to the budget that Congress permitted had to be "offsets" or "deficit neutral." Essentially, amendments which increased spending had to be compensated with a reduction somewhere else in the budget before they could be considered (16:94). With much debate and some creative forecasting, the joint budget resolution (26 June 1986) projected a debt of $142.6 billion--within the maximum ceiling set by Gramm-Rudman-Hollings of $144 billion (16:94-95). The threat of mandatory reductions appeared to compel the legislative and executive branches of government to work together to stay within the ceiling. The judiciary branch also had a vital role yet to be played.

The Law Revised. The day after Gramm-Rudman-Hollings became law, the constitutionality of the act was taken to court. By 7 July 1986, The Supreme Court "in a 7-2 decision struck down the automatic trigger mechanism... employing a strict interpretation of the separation of power doctrine" (16:97). Attempts to fix the constitutionality question bogged down in Congress and it still remained unclear during the closing days of FY 87. Despite this fact, Congress made major efforts to stay within the limits for FY 87 and FY 88 by increasing receipts and decreasing outlays (10:20).

Gramm-Rudman-Hollings, despite its many flaws, had at least made "federal deficits the top legislative priority..." and made the "budget growth between FY 86 and FY 87 the lowest in decades" (16:101). In October 1987, Congress passed the Balanced Budget and Emergency Deficit Control Reaffirmation Act of 1987, Public Law 100-119. Congress increased the deficit targets and resolved the constitutional issue. The new targets are $114 billion in FY 88; $136 billion in FY 89; $100 billion in FY90; $64 billion in FY 91; $28 billion in FY 92; no deficit in FY 93 (8:1). Also, the new law eliminates the constitutional issue by specifying the Director of the Office of Management and Budget, who works for the President, as the individual to call for the sequestration order (8:2). The law does not change the need or any of the problems associated with forecasting outlays.

Specific Problem

The Air Force Logistics Command (AFLC) Comptroller is interested in improving outlay forecasts for the Systems Support Division (SSD) of the USAF Stock Fund. The Air Force accounting system is designed to control obligation authority. Obligation authority allows an authorized person to contract for goods or services to be provided to the Air Force. The actual outlay or payment to the vendor may not occur until three months to three or more years later. Consequently, it is extremely difficult to forecast outlays.

One of the reasons that the SSD account was chosen for analysis is that its purchases represent a direct outlay from the Treasury. The SSD account was also chosen because of its significance in providing over 531 thousand expendable items for major weapon systems such as the B-1B, C-5B, and F-16. The SSD had a Total Financial Authority just over $4.6 billion in FY 87 (14).

The difficulty in forecasting SSD outlays was evident in FY 87 when the monthly and annual forecasted outlays were significantly understated. In fact, the end of year cumulative SSD outlay forecast was understated by $261 million (9:1). Outlay forecasts are the basis from which the Air Force, through the Office of the Secretary of Defense, requests money through the U. S. Treasury. Under the current mode of deficit spending, the Treasury borrows money to meet the cash requirements of the government. Incorrect forecasts (too high) cause the Treasury to borrow more than is actually required, thereby unnecessarily increasing the national debt. Forecasts which are too low cause a cash flow problem. The specific research problem is to find a way to improve the accuracy of forecasting SSD outlays.

Research Questions

1. What caused the need to forecast outlays?

2. Do private industries or foreign governments have similar problems forecasting outlays?

3. What forecasting methods are appropriate for forecasting outlays?

4. What variables affect the timelag from SSD fund obligation to fund outlay?

5. What is the relationship between relevant variables and outlays?

6. Can a regression model be developed to forecast outlays?

7. Is it possible to use a time series model to forecast outlays?

Scope

Although the purpose of this thesis is to find a better way to forecast SSD outlays, the introduction and literature review cover background material on the national debt and legislative actions taken to limit the debt. The scope of the literature and applicability of the thesis are focused by the fact that outlay control is a unique, U.S. government problem. Literature concerning private industries' problems in forecasting outlays is almost nonexistent because they use accrual accounting methods. Nor is there a plethora of information about foreign governmental problems with outlays as their accounting and political systems are different. The U.S. allocates a large portion of its budget to large, long lead time contracts for state-of-the-art weapon systems and parts (2:34). Most other countries depend more on existing, off-the-shelf technology for which long lead time contracts are not as prevalent. Another contributing factor

which makes the U.S. outlay problem unique is the legal environment which affects outlays. The full-funding principle, limited appropriation life, the Congressional Budget and Control and Impoundment Act of 1974, and the Prompt Payment Act are not common legislative policies in other western countries (19:12).

The literature search included the Defense Logistics Agency Defense Technical Information Center, the Defense Logistics Studies Information Exchange, professional journals, and an unpublished memo obtained from the staff of HQ AFLC. By design, the majority of the ideas and cited material are from professional journals.

It should be noted that this thesis is focused on forecasting outlays in the SSD, however, the methods or keys to forecasting SSD outlays may open doors for analysis of outlays in other appropriations.

Summary

The AFLC Comptroller is interested in improving outlay forecasts for the SSD portion of the USAF Stock Fund. This interest is driven by the overall government need to manage outlays, due to the growing emphasis on controlling the annual deficit. The Air Force's current accounting system focuses on controlling obligation authority, not outlays. Only Congress can change the current legal and political environment with which the United States government controls

its financial purse strings. This seems unlikely. Therefore, improved outlay forecasting methods are the best option offered in the literature on the subject. A review of the current difficulties in forecasting outlays and some background information on forecasting techniques seems appropriate.

II. Literature Review

Introduction

Any discussion concerning controlling the federal deficit must also describe the method of forecasting outlays--the driving force in determining the actual flow of cash from the government treasury. Without an accurate forecast of outlays, the deficit control measure is going to be difficult to implement. As identified earlier, a limitation on debt reduction laws is the inability to force limits on the deficit because the size and scope of the problem is not always known. Even with the Gramm-Rudman-Hollings requirements, an accurate model for forecasting outlays has still not been developed. Havens stated the following about the problems of forecasting outlays and revenues:

> After the end of fiscal year, the Treasury Department tells us the size of the budget deficit. Unfortunately, that is too late to do anything about it. To make the new law work, it is necessary to know ahead of time whether or not the actions taken to date are sufficient to bring the deficit in line with the target. That means working with estimates. Estimates of outlays and revenues are inherently imprecise because the outcome will be affected by events which cannot be fully known in advance [12:4].

In a 1 July 1987 memorandum, John E. Lang, Chief of Fiscal Analysis within the Budget Management Division, Directorate of Budget at the Air Staff responded to a directive from the Deputy Comptroller of the Air Force, to "develop recommendations to achieve positive outlay

controls" (15:1). Lang outlines the difficulties in controlling outlays because the current accounting system uses decentralized disbursements stations and is based on obligation authority control vice outlay control (15:1-2). To "illustrate the difficulties," he notes that $15.6 billion of FY 86 Air Force disbursements were made by "non-Air Force disbursing stations...Furthermore, of the $93.7 billion dispersed in FY 86, approximately 44% was against prior year appropriations" (15:2). The basic idea is that the Air Force, along with the other government activities, contracts for goods and services to be provided in the future. The window to obligate the funds could be from one to five years and the actual delivery and payment could occur one to three years after that (15:3). An Air Force requested Rand study provides some graphic portrayals of the problem.

Figure 2 illustrates in general terms the relationship between cumulative obligations and outlays for a "typical" Air Force procurement appropriation.

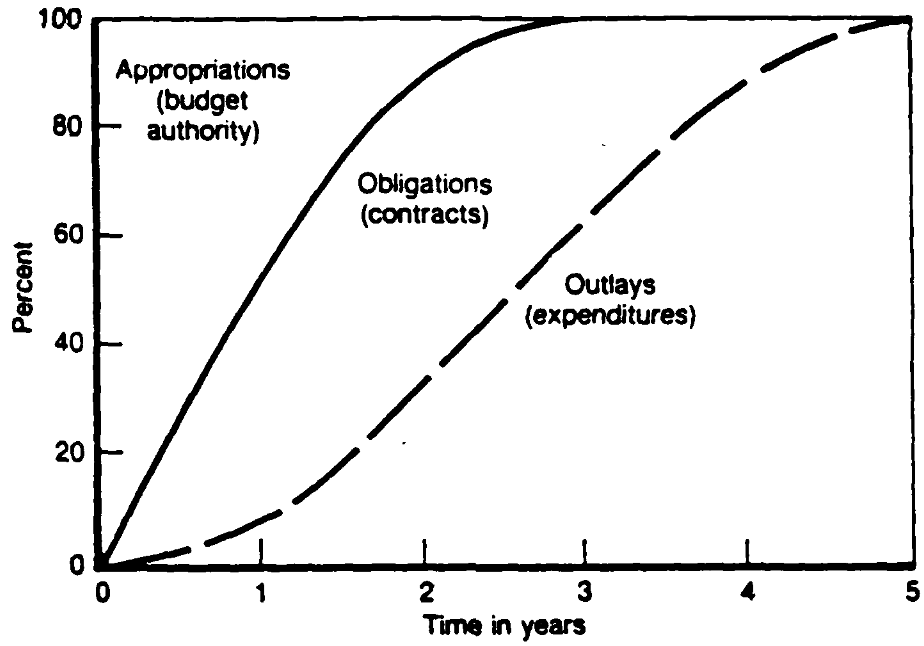

Figure 2. Typical Procurement Appropriation
Source: (19:4)

Figures 3 and 4 show that the relationship between the timing of obligations and outlays changes at the sub-appropriation level.

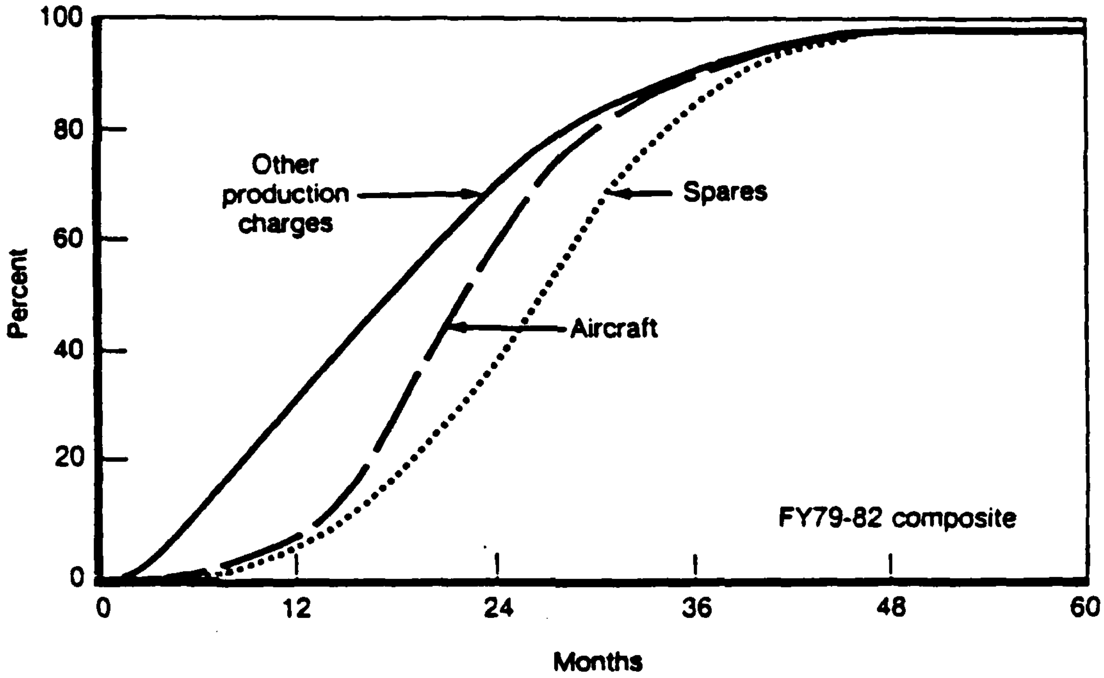

Figure 3. Outlay Patterns by Sub-appropriation for 3010
Source: (19:24-25)

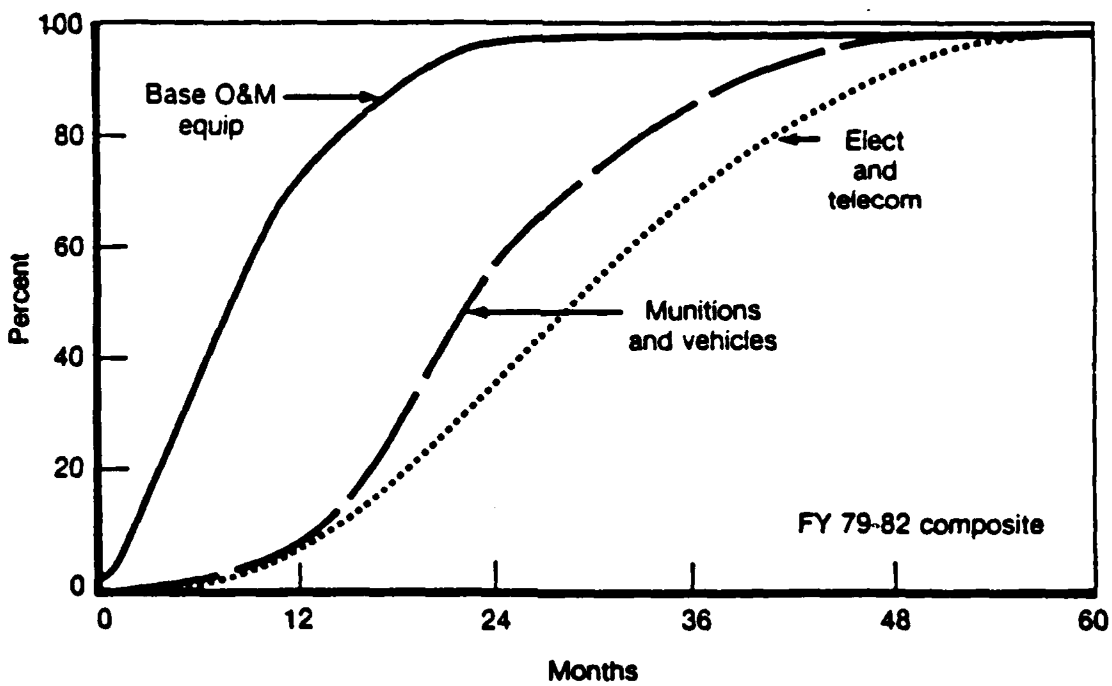

Figure 4. Outlay Patterns by Sub-appropriation for 3080
Source: (19:24-25)

The differences in these graphically portrayed patterns provide a visual display of the importance of analyzing outlays by sub-appropriation. A second factor is that these graphs were not considered accurate enough by Rand to make good forecasts. Their point is to demonstrate the importance of establishing and maintaining a current and accurate data base at the sub-appropriation level.

A third example of the need for improved outlay forecasting comes from a thesis entitled Cash Management in the Navy Stock Fund. The authors conclude that the "Navy Stock Fund end-of-period cash forecasts are inaccurate and need improvement" (17:148).

Factors Driving Improved Outlay Models

The main theme of both the Lang memorandum and the Rand study is the need for improved outlay forecasting at the sub-appropriation level (19:24, 15:4). The need for improved outlay forecasting is driven by the belief that the Air Force is constrained from making major changes in controlling outlays due to current policies. Those policies are: the full-funding principle; The Prompt Payment Act; The Impoundment Act; and the limited time an appropriation may be obligated. These policies have distinct benefits but all limit the ability of the Air Force to manage outlays (19 :12).

The full-funding principle is widely applied to today's contracts. The full-funding principle, which began in 1957, provided for longer contract terms, but also required that a

completed item must be produced. One of the intentions of the policy was to limit "foot-in-the-door" contracts. A side effect was a reduction in the ability to cancel contracts prior to an outlay occurring (19:13). The Prompt Payment Act of 1983 ensured "that federal agencies pay bills in a timely fashion and not pass financing problems of the government onto its vendors" (19:13). The Impoundment Act required the "..that the Executive obligate the full amount of appropriations unless Congress grants specific approval to withhold some or all of the funds" (19:13). The last point is that almost all Air Force appropriations have a specific window for obligation, normally one to three years. This policy limits the ability of the Air Force to indefinitely postpone obligations which will later cause outlays (19:13).

These are Congressionally-mandated policies which might be considered the "strings on the purse." They have all sought to strengthen the oversight of Congress and limit the executive's budgetary discretion. It is doubtful that Congress would provide more authority to the executive in controlling outlays as is the case, for example, in the United Kingdom (19:16).

In the United Kingdom, an outlay instead of an obligation budgeting system is used with the executive accorded a great degree of authority to:

> ...transfer funds within and among programs... authority to rescind, impound, or defer obligation of funds...authority to budget for contingencies...adjust outlay targets...pay interest for short-term deferrals of bills...relaxed use of full-funding principle ... powers to terminate contracts, slow them down, or stretch out payments...obtaining supplemental appropriations one or more times in the course of a single year [19:16].

Variable Identification and Specification

Variable identification and specification was accomplished by interviewing the Chief of the Investment Fund Division, HQ AFLC Directorate of Budget, and the budget analyst responsible for SSD outlay forecasting. These interviews resulted in the identification of potential variables which may contribute to the timing of outlays. Variables selected include SSD obligations, sales, collections, deliveries, and disbursements.

Specification of logical relationships between the relevant variables and SSD outlays prior to the actual statistical analysis was accomplished. After extensive discussions with Mr. Jim Howe, HQ AFLC SSD budget analyst, the following definitions and relationships were established:

> An obligation occurs when the Air Force agrees to pay a contractor who will provide a good or service in the future based on a contractual agreement.
>
> A delivery represents the contractors completion or delivery of a service or good. Payment is now usually authorized. Deliveries of SSD items are believed to

occur twelve to eighteen months after the original obligation. This time lag is frequently referred to as procurement lead time (PLT).

A disbursement is a payment to a contractor who has provided a good or service to the Air Force.

A sale occurs when a customer, such as Strategic Air Command, orders and is sent a part from the existing AFLC SSD inventory.

A collection is made when funds, usually the customer's operations and maintenance funds, are collected into the SSD account. A customer in this case is another Air Force activity, such as an operational command. Collections are believed to occur thirty to sixty days after a sale.

An outlay is the difference between disbursements and collections for any given period (i.e. monthly, quarterly, or annually). Outlays are believed to occur twelve to twenty months after obligations. Another measure is that outlays are believed to occur thirty to sixty days after deliveries.

The knowledge of these relationships indicates that an historical pattern to the data may exist and that a forecasting model may be applied.

Background Information on Forecasting

According to some experts in the field of forecasting, the emphasis in using forecasting techniques has moved from the primarily technical field to "encompassing a much broader set of planning, decision-making and managing issues" (26:ix). As management understands more about the nature of forecasting, a realization occurs that a large portion of all management decisions involve forecasting of one sort or another. The literature categorizes forecasting methods in a variety of ways. This paper categorizes forecasting into three major approaches: judgemental, subjective, or qualitative methods; technological, or normative methods; and quantitative, time-series, or regression methods.

Market research or customers' preference, juries of executive opinion, and intuitive individual judgement are examples of judgemental forecasting. Forecasts made by an individual or by committee are considered the most common forecasting method used by business and government (26:10). In general, judgement or qualitative methods "...involve subjective estimation through the opinions of experts" (20:7).

Technological is somewhat a new category, containing involved forecasting methods such as morphological research, systems dynamics, and cross impact. Technological methods are geared primarily at engineering and operations research

(26:16). Their application in forecasting outlays is probably not appropriate.

Quantitative forecasting includes naive or rule of thumb methods, time series, decomposition, and regression. These methods require that the logic be stated and the mathematical relationships known (20:7). This paper concentrates on regression and univariate time series models.

Causal forecasting methods, which includes regression, "exploit the relationship between the time series of interest and one or more other time series. If these variables are correlated... a statistical model describing this relationship can be constructed" (20:7). A time series is the "...time-ordered sequence of observations of a variable" (20:7). Exponential smoothing and decomposition are two categories of univariate time series forecasting techniques.

Exponential smoothing techniques use averages but apply weights to past data. The weights decay in an exponential manner causing data that is further removed from the current time to have less influence (26:54). The basic idea of exponential smoothing techniques is that there is an underlying pattern to the variables along with some degree of random fluctuation. The goal is to "eliminate extreme values found in the historical sequence and basing a forecast on some smoothed intermediate values" (26:55).

Decomposition techniques attempt to separate the basic underlying pattern into trend, cycle, and seasonal components. The trend identifies the long-run increase, decrease, or unchanged pattern of the data (26:83). The cycle is common to series such as consumer demand items in the private economy or the gross national product. The cycle is the "ups and downs" generally associated with a period longer than one year. The cycle is difficult to gage due to its lack of uniformity of intervals and duration (26:49). Seasonality appears obvious when discussing heating oil, ice sales or rakes, but there are other less obvious seasonal variables, such as a firms internal operations (26:49). A firm's tax year, fiscal year, labor pool or material availability are examples of variables which could cause a seasonal pattern.

Forecasting seeks to remove uncertainty about the future and aids decision makers in assessing the future from which to build a plan. Forecasting models are generally based on fitting a model to the past. This may aid in describing the future but it is by no means a guarantee. Selection of the "best" forecasting method is not always a clear choice. Some in the field have proposed using multiple forecasting techniques and then combining or averaging the results (20:36).

Although not a perfect science, forecasting appears to have grown in management application; more quantitative methods, such as regression and time series, have increased

in popularity. Financial planning and in particular cash flow problems lend themselves to forecasting techniques (20:2).

Summary

A consistent theme of existing literature is to develop data bases and analyses of outlays at the sub-appropriation level. Outlays in the SSD represent a sub-appropriation. This is a ripe area for study as the expenditures in the SSD represent actual disbursements from the U.S. Treasury and have consistently been a problem to accurately forecast. Forecasting outlays in the SSD is particularly difficult because the calculation of outlays is based on two fairly independent events: disbursements and collections. Most other appropriations need only accurately forecast disbursements. Although the literature concerning government outlays calls for data collection and analysis at the sub-appropriation level, it does not offer specific analytical methods. It is hoped that regression or univariate time series methods will aid in forecasting SSD outlays.

III. Methodology

Introduction

This portion of the study describes the method used to answer the research questions posed in Chapter I. The approach was to build a multivariate or univariate model which would forecast outlays on a quarterly basis for the last two quarters of FY 88 and all four quarters of FY 89. This chapter also includes a discussion of the general regression model, time series univariate models, and the outline of the approach methodology.

Statistical Analysis

The initial step of the analysis uses a Pearson Correlation Matrix to test the statistical relationship between relevant variables and SSD outlays. The second step is an attempt to develop a regression model to forecast SSD outlays. The general model of the standard form was used (21:230):

$$Y_i = B_o + B_1 X_{i1} + B_2 X_{i2} + E$$

where: $B_o, B_1 \ldots, B_k$ are parameters

$X_{i1}, \ldots, X_{ik}$ are constants

E_i are independent and normally distributed

$i = 1, \ldots, n$

Lastly, use results of the statistical analysis to determine prediction intervals for future outlays (21:76). Testing the model to determine its accuracy in forecasting SSD outlays involves using the model to forecast outlays and then comparing actual to forecasted outlays. The Statistical Analysis System (SAS), version V5.16, was used on the AFIT VAX 11/785 CSC Classroom Support Computer (CSC).

Univariate Time Series Analysis

Three univariate time series models were also considered: Holt's Two Parameter Linear Exponential Smoothing Model; Winters' Three Parameter Linear and Seasonal Exponential Smoothing Model; and the Census II Decomposition Method. All are available on the AFIT VAX 11/785 CSC computer contained in FUTURCAST. FUTURCAST is a comprehensive time series analysis package authored by Dr. Spyros Makridakis and Dr. Robert Carbone (11). The three models were selected to permit a cross check. This also allowed comparison of their accuracy measures of model fitting. Those measures considered were Mean Percentage Error, or Bias (MPE); Mean Absolute Percentage Error (MAPE); Mean Absolute Deviation (MAD); Root Mean Squared Error (RMSE); Theil's U-statistic (original data); and Times Series R-square. The Holt and Winter techniques fall into the time-series smoothing methods category, while Census II is considered a decomposition method.

Holt's model comprises two smoothing equations and a forecasting equation (18:85; 26:67):

$$S_t = aX_t + (1-a)(S_{t-1} + T_{t-1})$$

$$T_t = b(S_t - S_{t-1}) + (1-b)T_{t-1}$$

$$F_{t+m} = S_t + mT_t$$

where S_t is the equivalent of a single exponential smoothed value,

a is a smoothing coefficient between zero and one,

b is a smoothing coefficient, analogous to a, and

T_t is the smoothed trend in the data series

F_{t+m} is the forecasted value for the period t+m.

"One smoothes (i.e., averages) the level of the data; and the other smoothes the trend only. Forecasts are obtained by combining the smoothed estimates of the data and then adding the possible trend, if one exists" (11).

Winters' smoothes "the general level of a time series, its trend, and seasonality" (11). Winters' is considered an extension of Holt's model adding the indexed seasonal equation.

Listed below are the three equations used in Winters' and the forecast equation (26:69-70).

$$I_t = b\frac{X_t}{S_t} + (1-b)I_{t-L}$$

$$S_t = a\frac{X_t}{I_{t-L}} + (1-a)(S_{t-1} + T_{t-1})$$

$$T_t = v(S_t - S_{t-1}) + (1-v)T_{t-1}$$

$$F_{t+m} = (S_t + mT_t)I_{t-1+m}$$

where S_t is a smoothed value of the deseasonalized series,

T_t is a smoothed value of the trend,

I_t is a smoothed value of the seasonal factor, and

L is the length of seasonality (e.g., number of months or quarters in a year),

F_{t+m} is the period in the future to be forecast

Census II was developed by Julius Shiskin of the U.S. Census Bureau in the mid-fifties. It has been widely used by the government and more recently by private industry (26:103). Census II calculates the seasonal factors by using ratio of the original data to a 12-month moving average, eliminates extreme values above or below three standard deviations, smooths irregular movements, then identifies the cyclical movements of the data (26:104).

Shown below is the most basic representation of the iterative process used by Census II (26:84).

$$X_t = f(S_t, T_t, C_t, E_t)$$

where X_t is the time-series value (actual data) at period t,

S_t is the seasonal component (or index) at period t,

T_t is the trend component at period t,

C_t is the cyclical component at period t, and

E_t is the random component (or error) at period t.

Outline of the Appraoch

The research methodology is divided into six steps:

1. Collect data on outlays and the applicable variables from FY 83 through FY 88 2nd quarter. Normalize data if required. This includes changing the monthly/quarterly data, based on documentation from the HQ AFLC budget analyst, and using the data on a quarterly basis to smooth out accounting irregularities and errors.

2. Graph the data and observe patterns to determine possible relationships between the variables.

3. Accomplish some basic statistical analysis by calculating annual, quarterly, and monthly averages and standard deviations for each variable.

4. Develop a statistical relationship between relevant variables and outlays. These relationships will be

developed into a regression model which forecasts SSD outlays.

5. Develop univariate time series models using Census II, Holt, and Winters'.

6. Analyze each model and compare the forecasts of all models to the actual outlays and HQ AFLC's forecasts for the 3rd quarter of FY 88.

Summary

Each step of the above approach should provide incremental insight into the nature of outlays and the associated variables. Obtaining the data, normalizing the data, looking for graphic patterns, performing basic statistics and attempting to apply a model to the pattern are the steps used to find a better way to forecast SSD outlays.

IV. Analysis and Findings

Introduction

This chapter describes the research activity consistent with the seven steps of approach described in Chapter III, Methodology. First, however, some factors that affect forecasting outlays are discussed.

Factors Affecting Outlay Forecasting

Listed below are factors affecting forecasting oulays.

1. An item may be delivered and go to stock or it may be immediately sent out to a customer. Items going to stock result in disbursements without a corresponding sale or collection.

2. Accounting data in the historical data bank are not always accurate. Anomalies resulting in accounting errors or reporting errors are not always reported to HQ AFLC in time for corrections to be made in the month the error occurred. Therefore, some monthly historical data are not accurate. A thorough review with the HQ AFLC SSD budget analyst was accomplished to correct known errors and to normalize some of the anomalies in the data. These changes are reflected in Appendix A.

3. Outlay patterns might change with policy directives. An example is the Office of the Secretary of Defense for Financial Management imposed a significant

obligation policy change beginning with the 3rd quarter of FY 87. That change required AFLC to obligate 100% of their quarterly obligation authority during each quarter rather than managing SSD funds on an annual basis. This was done to prevent the large obligations which had occurred during the last quarter of FY 83 through FY 86 (14). This policy might, in time, significantly smooth outlays if a consistent procurement lead time can be established.

4. The amount of appropriated funds for Inventory Augmentation has large fluctuations between fiscal years. The Inventory Augmentation Program began in FY 84 with approximately $35 million (14). By FY 88 the funded requirement had risen to around $126 million. The proposed Inventory Augmentation Program for FY 89 is $232 million (3). Appropriated funds result in disbursements without a dollar-for-dollar sale and collection. Instead a "sales-offset" is computed which results in a 25% to 30% sale and collection back to the SSD (14). Obviously, if appropriated funding increases, total outlays will increase as only 25% to 30% of the disbursements will have a "sales-offset."

Data Collection and Normalization

Appendix A displays the raw data on sales, collections, obligations, deliveries, disbursements, and outlays captured in the Air Force Stock Fund Systems Division Operating Program Exhibit SF-4 and Supplemental Cash Budget SF-5 (4,5). Appendix B contains the normalized

data with footnotes as to reasons for changes. A major normalizing decision was made concerning the treatment of refunds. Refunds are large SSD payments that are paid back to the Operations and Maintenance (O & M) appropriations. Refunds increase outlays and decrease collections and sales. Listed below is a history of refunds paid from the SSD to O & M accounts.

FISCAL YEAR	MONTH	AMOUNTS IN MILLIONS OF DOLLARS
FY 84	JULY	22.7
FY 84	AUGUST	22.7
FY 85	MARCH	173.9
FY 86	JANUARY	212.7
FY 86	APRIL	87.3
FY 87	JULY	270.0

The large dollar amounts involved caused outlays, collections and sales to show significant correlation during the initial data analysis. This high level of correlation was considered artificial or not naturally occurring in the accounting process. Therefore, refunds were removed from the data by decreasing outlays and increasing collections and sales in the months that they occurred. In FY 88 the practice of altering outlays, collections, and sales was discontinued due to a policy change by OSD Financial Management (14). Refunds will still occur, but the revised accounting method will affect the stock funds cash fund, not outlays, collections, or sales. The final, normalized, data set which was used for the all further analysis is contained in Table 1.

TABLE I

NORMALIZED DATA: QUARTERLY NON-CUMULATIVE

		SALES	COLLECT-TIONS	OBLIGA-TIONS	DELIV-ERIES	DISB-MENTS	OUTLAYS
FY83	1ST QTR	410.1	411.9	344.4	417.9	494.7	82.7
	2ND QTR	436.7	399.2	410.3	447.8	444.6	76.5
	3RD QTR	423.3	444.7	466.1	481.0	463.8	19.2
	4TH QTR	426.8	481.3	578.4	438.3	409.8	-15.5
FY84	1ST QTR	447.8	441.1	330.5	400.3	414.9	-26.1
	2ND QTR	495.0	480.3	380.9	434.8	417.3	-62.8
	3RD QTR	467.1	459.5	381.3	421.9	417.1	-42.5
	4TH QTR	426.7	477.0	1104.5	455.7	349.0	-37.1
FY85	1ST QTR	380.2	368.3	137.2	337.3	393.0	24.6
	2ND QTR	390.6	388.0	338.7	412.9	394.3	6.2
	3RD QTR	422.9	440.9	445.9	414.8	403.9	-36.8
	4TH QTR	451.0	467.4	783.4	465.2	423.7	-43.7
FY86	1ST QTR	366.5	335.3	260.9	398.9	469.9	134.6
	2ND QTR	341.9	329.4	272.7	425.0	404.2	74.6
	3RD QTR	313.9	319.1	398.2	470.8	416.3	97.2
	4TH QTR	339.5	333.4	793.5	399.7	445.8	112.4
FY87	1ST QTR	345.5	332.0	358.2	418.4	436.0	104.1
	2ND QTR	354.0	369.9	323.4	491.0	452.4	82.5
	3RD QTR	379.9	355.6	359.5	419.8	452.6	97.0
	4TH QTR	362.9	386.0	485.3	443.6	440.8	54.8
FY88	1ST QTR	357.6	336.3	343.9	434.3	418.2	81.9
	2ND QTR	321.7	319.4	297.9	377.3	419.8	100.3

Graphic Analysis of the Data

All graphs in this section use the normalized quarterly data from Table 1. Graphs were produced using Harvard Graphics on a Zenith 248 micro computer. Variables were graphed together based on their known relationships to each other: sales to customers cause collections from the customers; deliveries by a supplier result in disbursements from the government to the supplier. Each graph was evaluated in terms of possible seasonal, cycle, and trend patterns. One should note that FY 88 data points are for the 1st and 2nd quarter only.

Figure 5 graphs sales and collections and in fact shows that they have a similar pattern. The pattern tends to start out low in the 1st quarter and increase through the 4th quarter, suggesting seasonal behavior. A not so obvious cycle pattern may exist creating an "s" curve every two years. The overall trend shows a decline in sales and collections since FY 84.

Figure 6 plots the cumulative quarterly sales and collections since FY 83. As would be expected from quarterly summed data, the two lines parallel each other as collections should occur within 30 to 60 days of the sales.

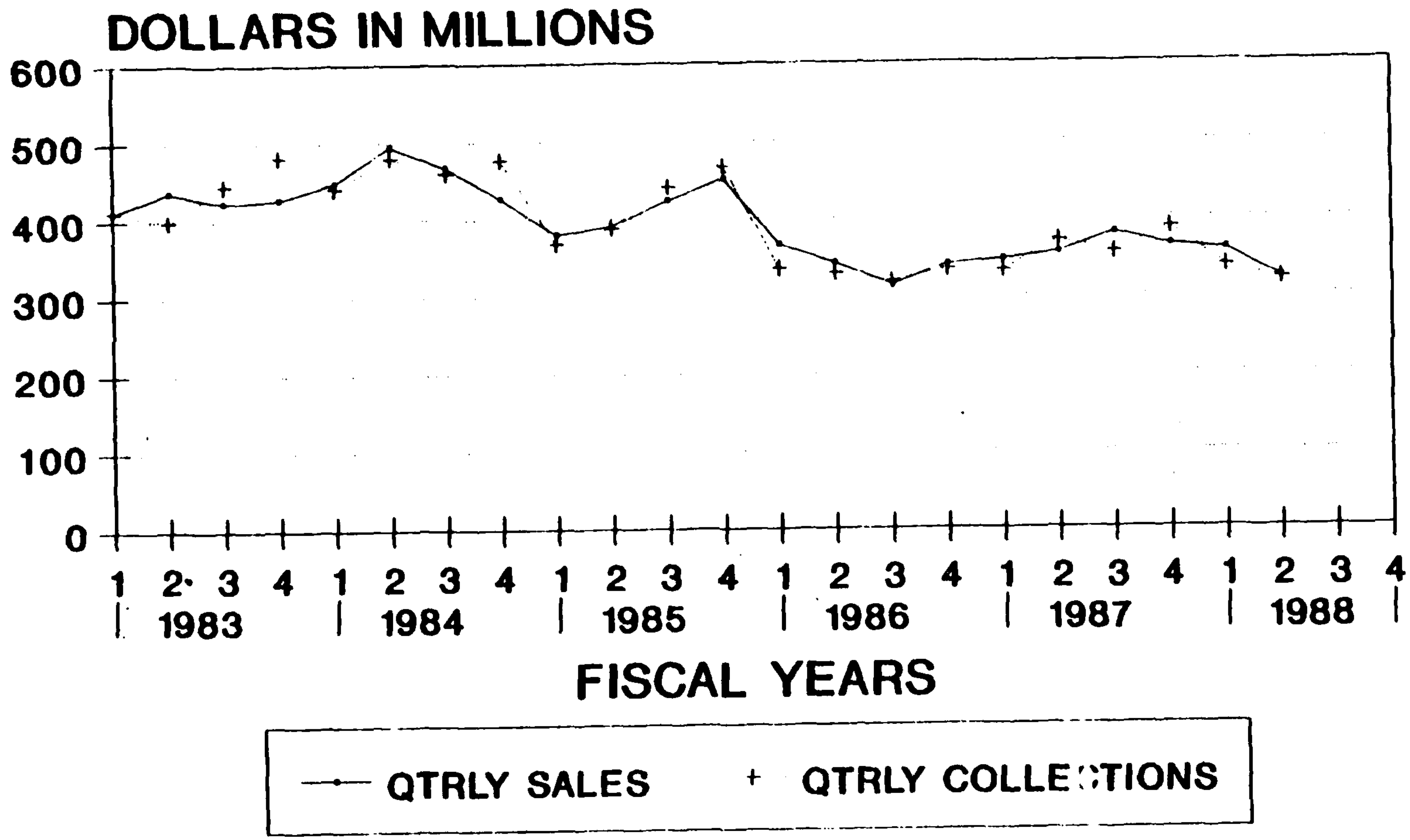

FIGURE 5. QUARTERLY SALES AND COLLECTIONS

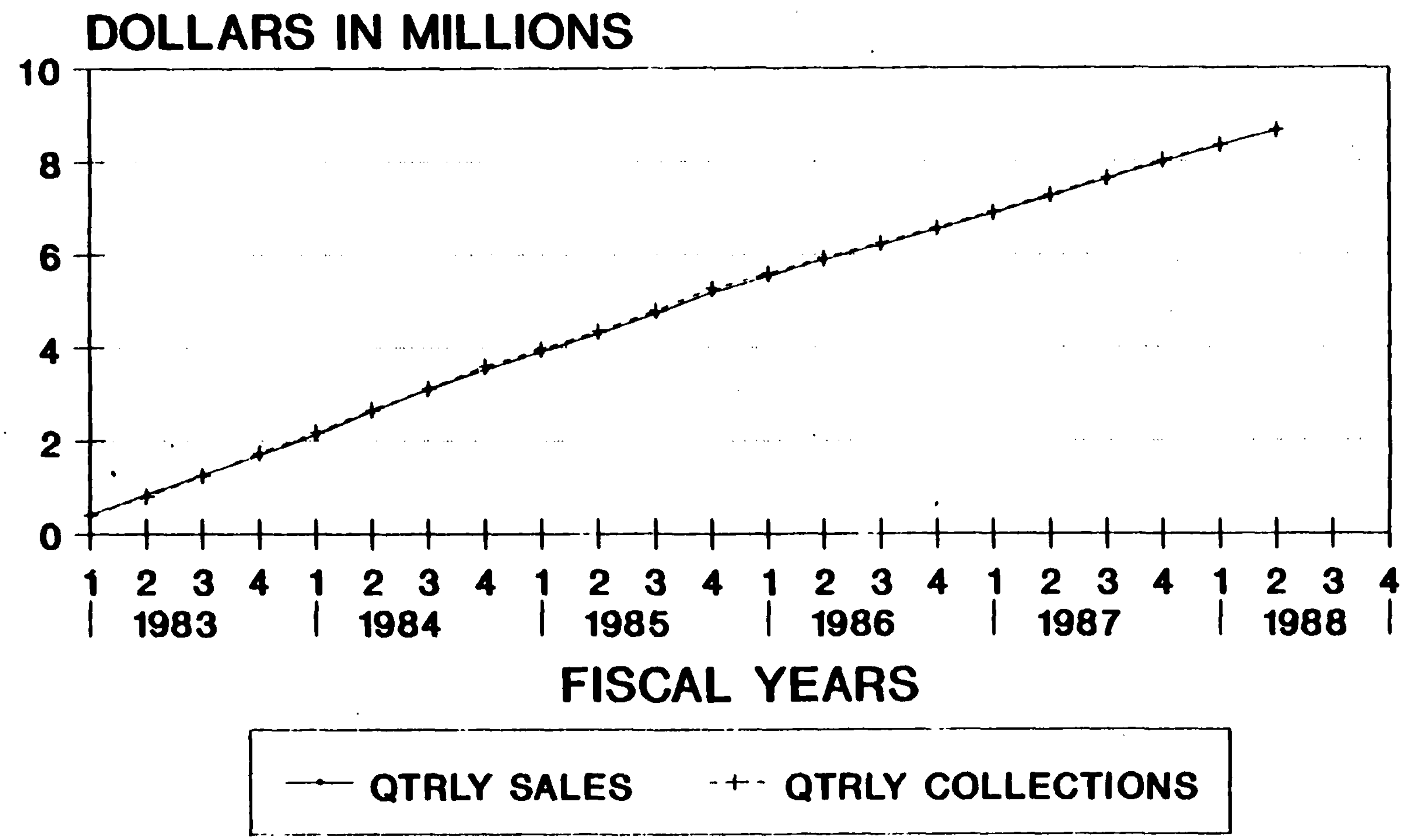

FIGURE 6. CUMULATIVE QUARTERLY SALES AND COLLECTIONS

Figure 7 plots deliveries and disbursements. Although these two variables have a similar pattern, they do not appear to have as strong a correlation as sales and collections. FY 84 and FY 85 deliveries show seasonal behavior (steady increase from the 1st through 4th quarters), but this pattern does not hold true for the other fiscal years. One might expect a seasonal pattern in deliveries due to the seasonal pattern in obligations. This is only true if there is some standard PLT expected. Deliveries frequently increase for three or four quarters and then show a sharp decline. The 1st quarter is the most frequent data point for a decline in deliveries. For both deliveries and disbursements, a cyclical pattern is difficult to distinguish, and no steady trend is obvious.

Figure 8 plots the cumulative quarterly deliveries and disbursements. The two closely track each other with deliveries occurring marginally before disbursements.

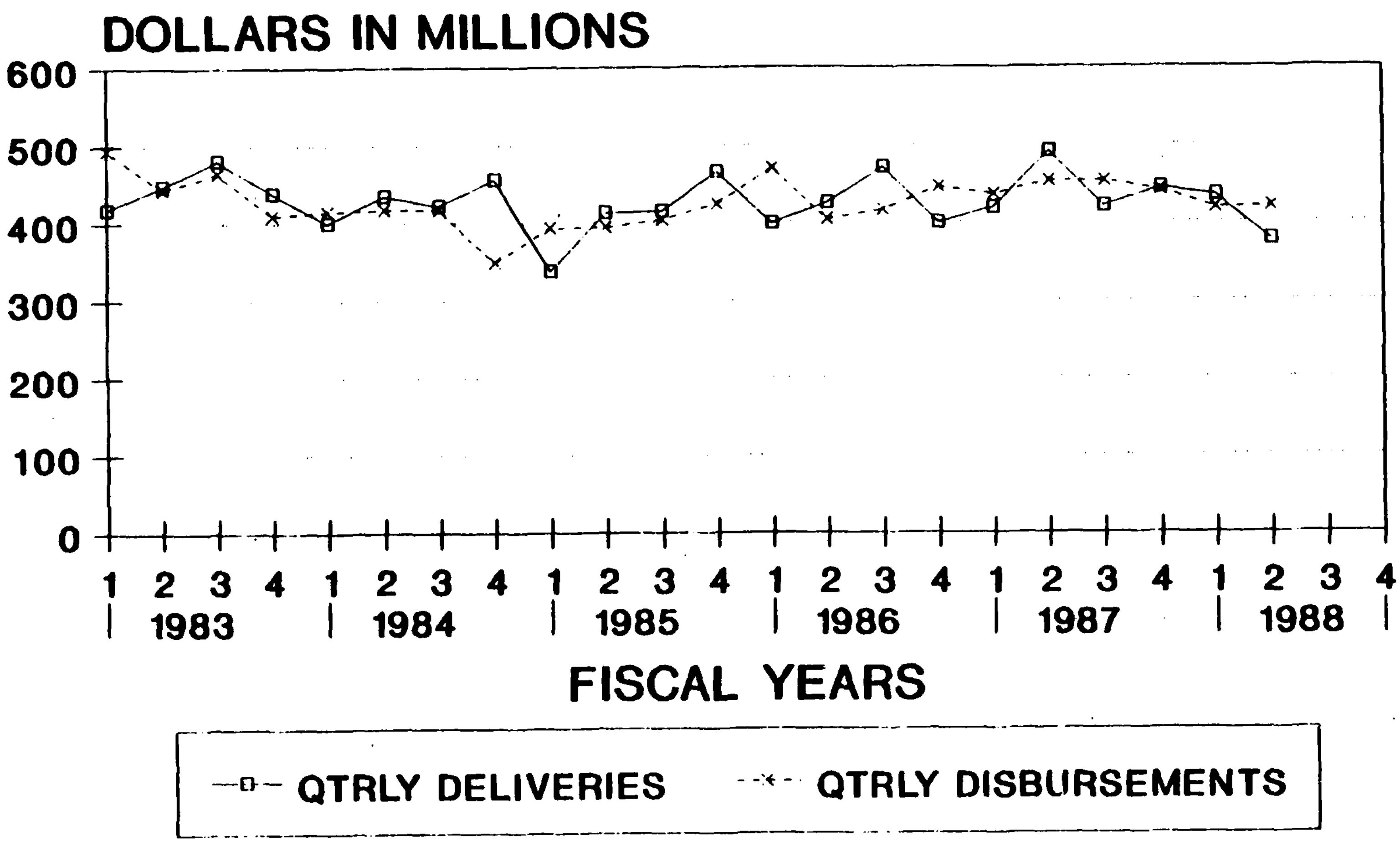

FIGURE 7. QUARTERLY DELIVERIES AND DISBURSEMENTS

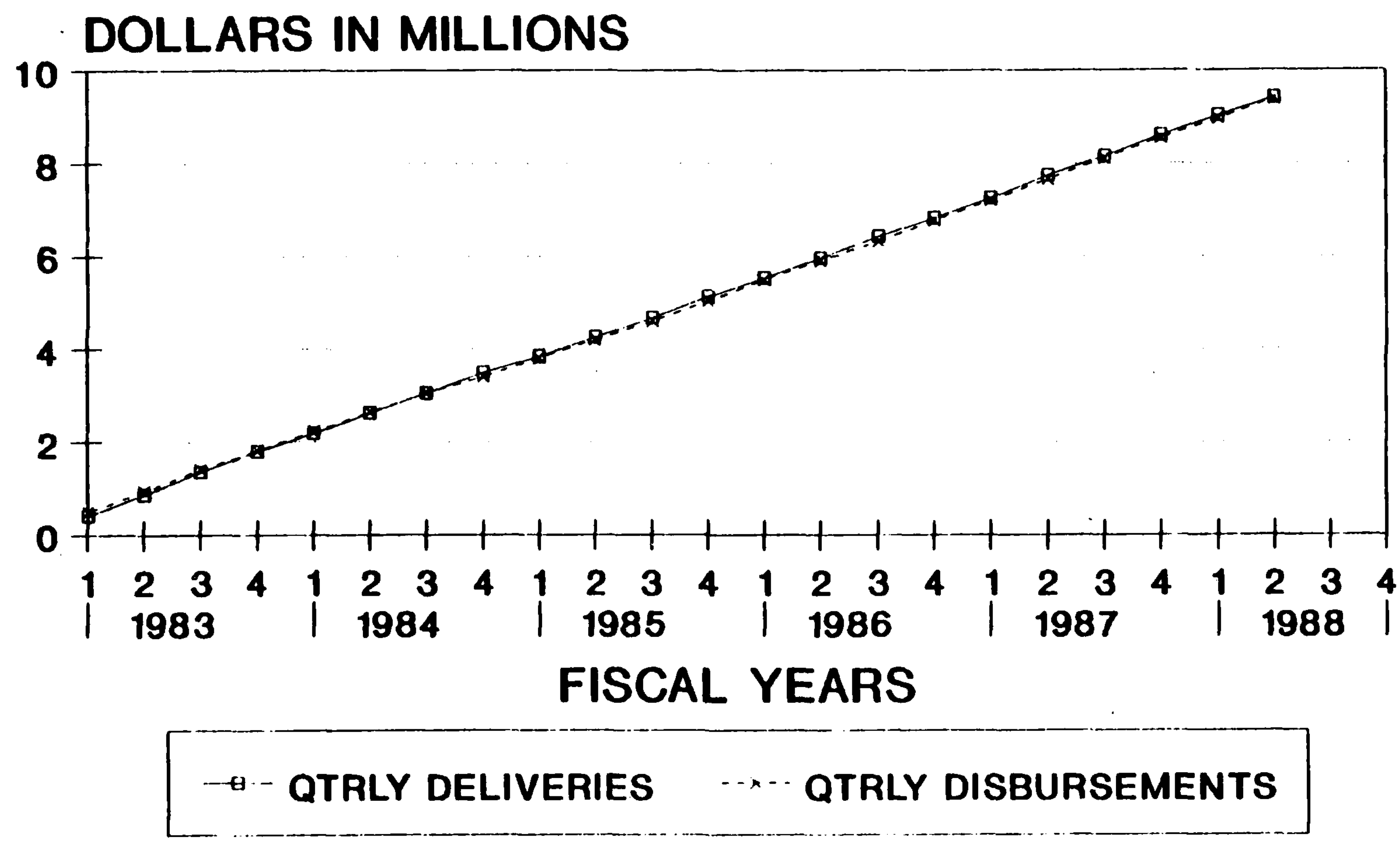

FIGURE 8. CUMULATIVE QUARTERLY DELIVERIES AND DISBURSEMENTS

Figure 9 plots quarterly obligations. An exceptionally strong seasonal behavior exists for all years, although not as dramatic in FY 87. A long term cycle is difficult to see due to the large spikes in the 4th quarter. The 4th quarter spikes also obscure the overall trend. It is difficult at this point to determine the effect of the OSD policy of requiring 100% of quarterly programs be obligated, but the sharp reduction in the size of the FY 87 spike may reflect a change in the pattern.

Figure 10 plots cumulative quarterly obligations, disbursements, and collections. Since obligations begin the process which leads to disbursements collections, it was hoped that a visual timelag would present itself. The graph indicates that since FY 84, obligations increased while disbursements remained about the same. Collections actually dropped compared to the other variables after 2nd quarter of FY 86. This is consistent with the increase in appropriated funding for the Inventory Augmentation Program discussed earlier in this chapter. As stated, an increase in this program will cause increases in obligations, deliveries, and disbursements but will only result in a 25% to 30% "sales-offset." Therefore as appropriated funding has increased since FY 84, collections should drop relative to obligations and disbursements.

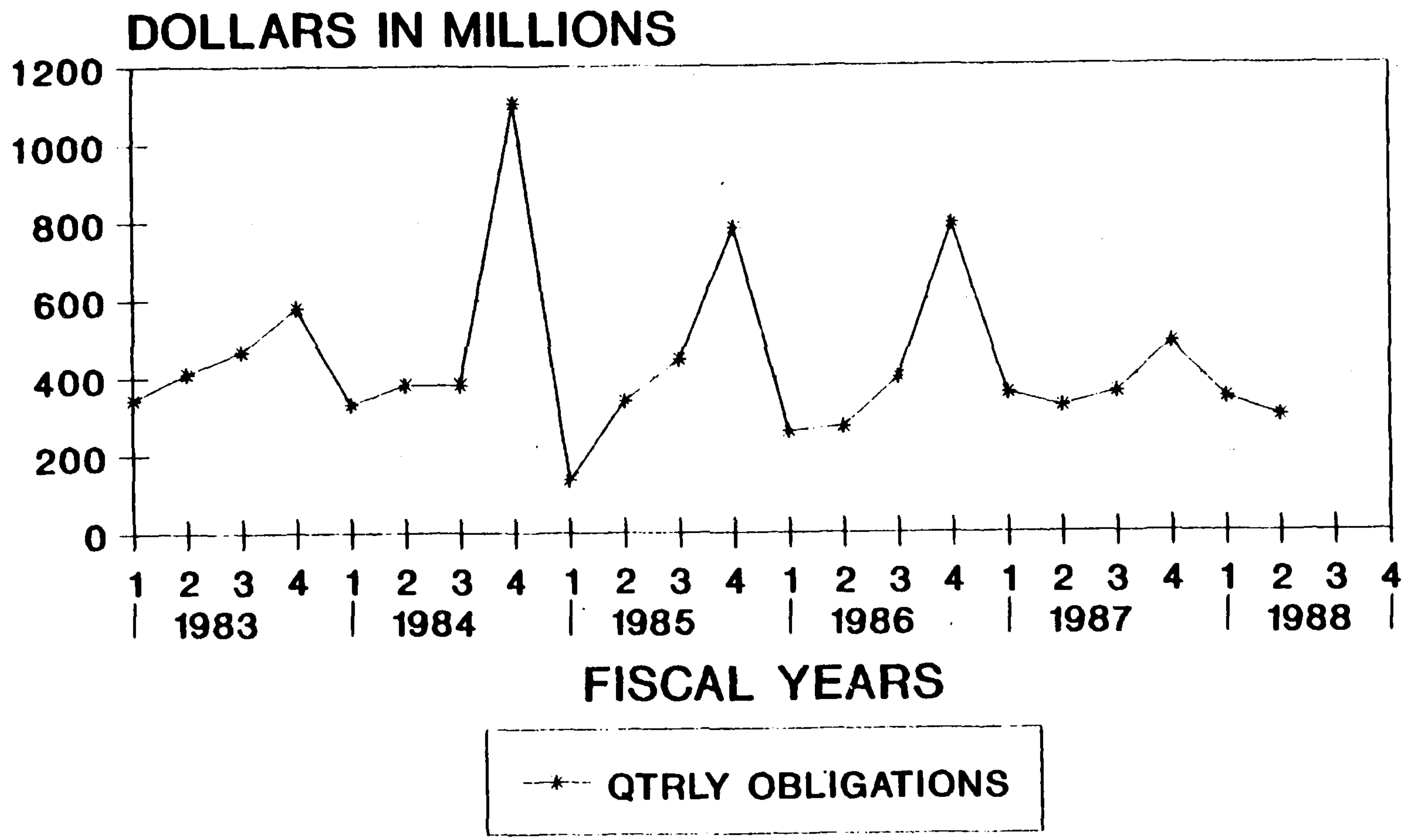

FIGURE 9. QUARTERLY OBLIGATIONS

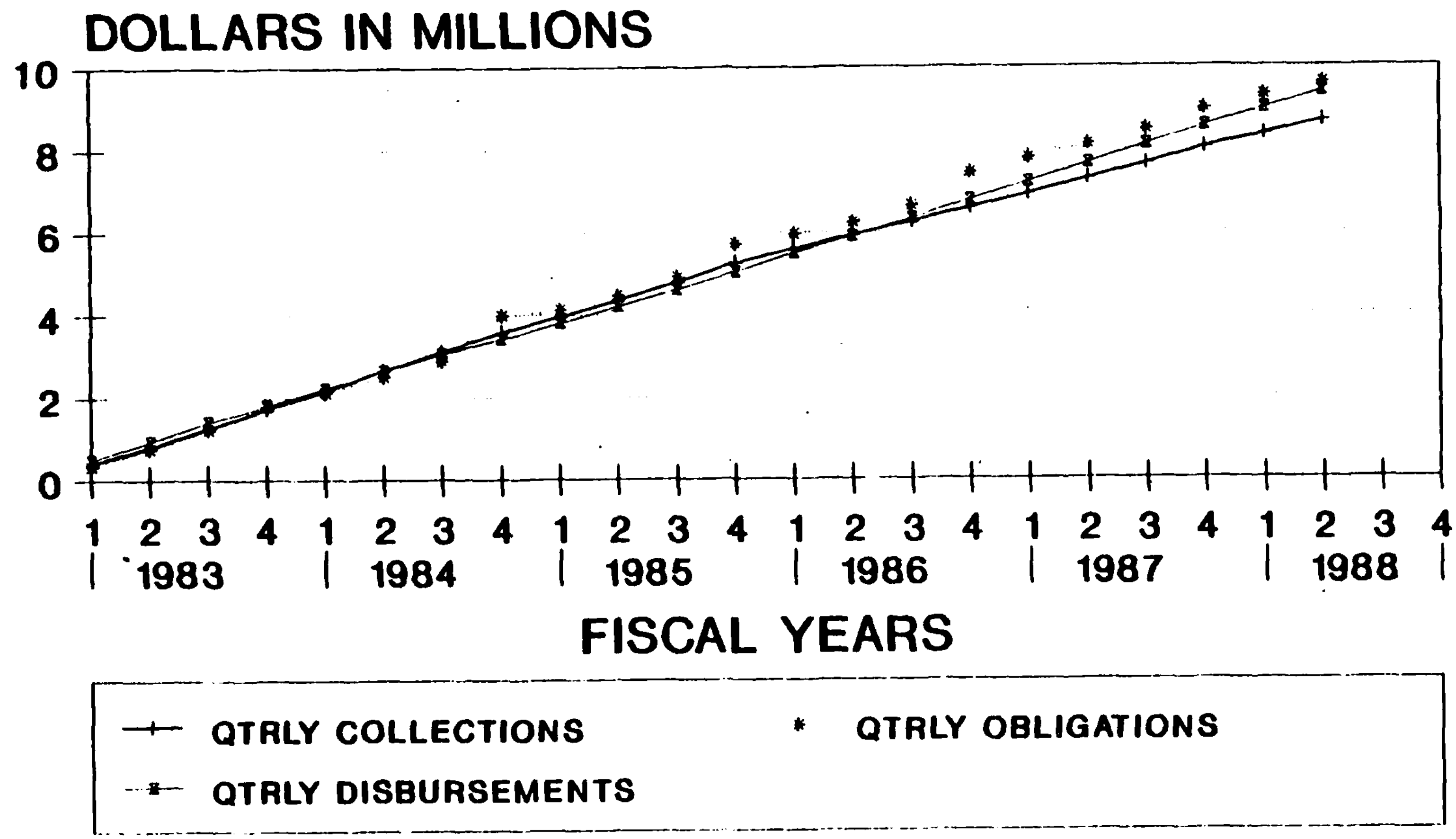

FIGURE 10. VARIABLES AFFECTING OUTLAYS

Outlays are displayed in Figure 11. One should note the occurrence of a negative outlay. Negative outlays occur when collections exceed disbursements. This situation was common in FY 84 and FY 85. Outlays since FY 86 have all been positive (i.e. disbursements have exceeded collections). This is also in part due to the increase in appropriated funds for Inventory Augmentation. The trend in outlays is obviously increasing since FY 84.

Figure 12 plots cumulative obligations and outlays as did the Rand study previously cited in the literature review. Due to the effect of collections, an obvious lag pattern is not present.

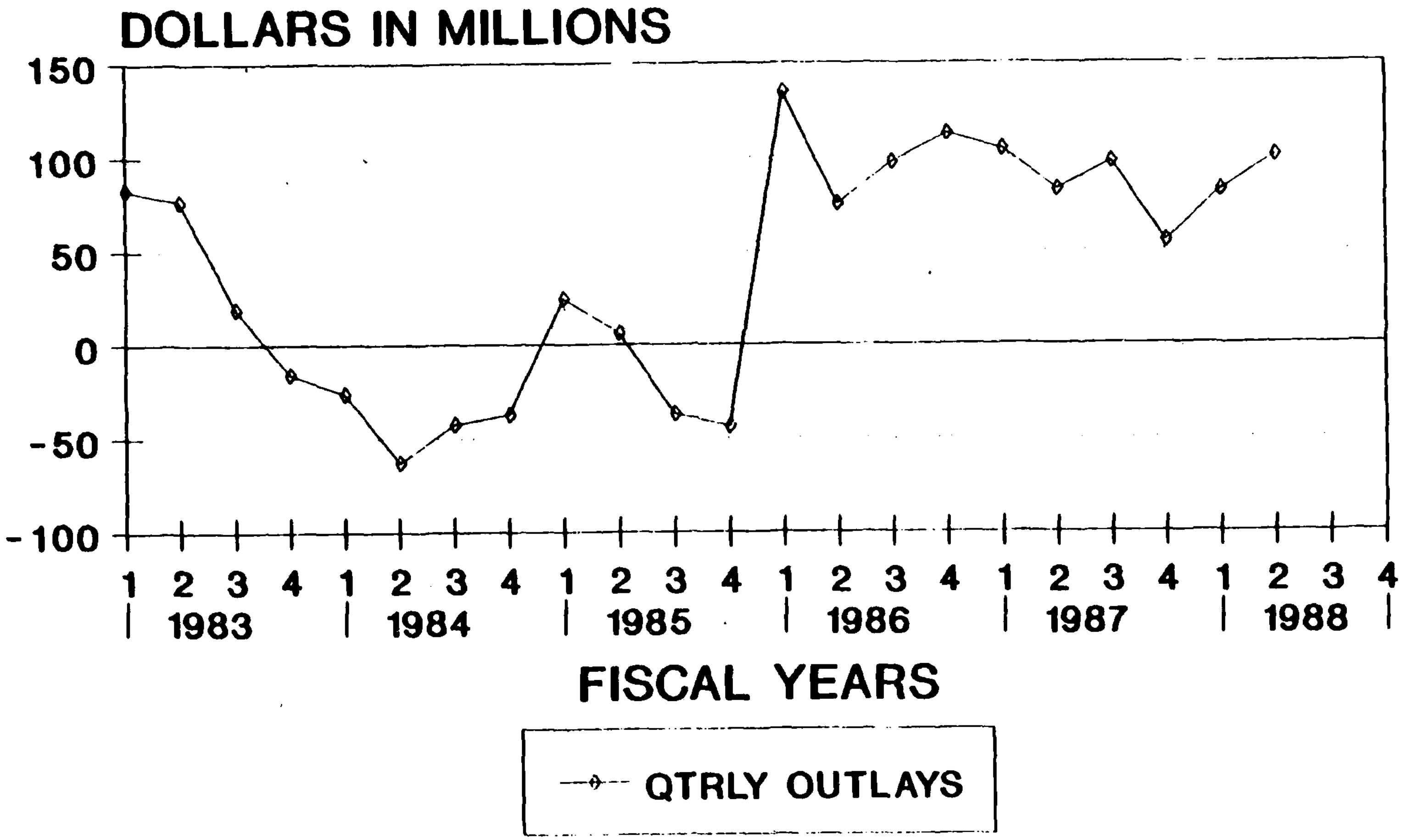

FIGURE 11. QUARTERLY OUTLAYS

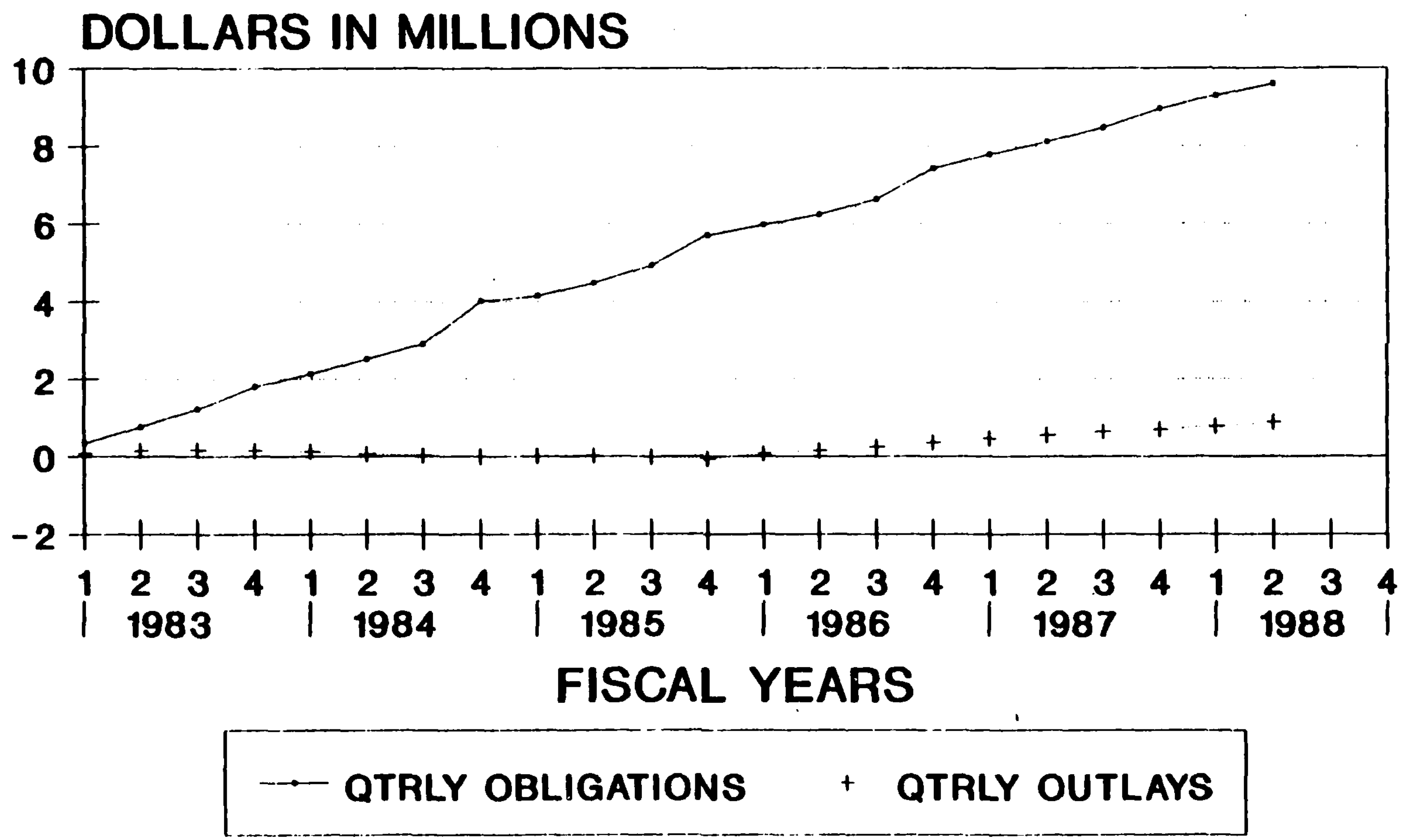

FIGURE 12. CUMULATIVE QUARTERLY OBLIGATIONS AND OUTLAYS

Basic Statistical Analysis

Annual and quarterly averages and standard deviations are shown in Tables 2 and 3. Monthly averages are contained in Appendix C. The analysis presented in the following paragraphs concentrates on quarterly data for seasonal patterns and annual data for long term trend. It should be noted once again, that FY 88 quarterly data is only for the first two quarters of the fiscal year (September through March). As the historical quarterly averages indicate, 3rd and 4th quarter activity may be the most active for sales, collections, obligations, and deliveries; therefore, the FY 88 averages in Tables 2 and 3 may be understated. Many of the observations echo the previous analysis accomplished with graphs.

Sales on average are greatest in the 3rd and 4th quarter and appear to be decreasing since 1984. Collections are also significantly larger in the 3rd and 4th quarter and have steadily declined since 1984. Obligations show a steady increase among the quarters, with the 4th quarter double and triple other quarters obligation rates. Due to the policy change identified earlier, obligations among quarters smoothed in FY 87. Obligations since FY 84 have steadily decreased. Deliveries and disbursements are fairly stable between quarters and among fiscal years with the lowest standard deviation of all variables. Outlays present the most widely dispersed data

with the standard deviation frequently exceeding the quarterly average.

Quarterly outlays averaged $40.2 million since FY 83, with FY 84 averaging $-42.1 million and FY 86 averaging 104.7 per quarter. Outlays are highest in the 1st quarter and lowest in the 4th. This is consistent with disbursements remaining relatively stable (with a slight decrease in the 4th quarter) and collections steadily increasing.

These various averages could be used to provide forecasts of outlays or any of the other variables in the data base. This analysis provides a basic foundation for understanding variable patterns in the SSD. However, more advanced analysis is required to decrease the margin of error experienced when using just the average to forecast.

TABLE 2-1

AVERAGES AND STANDARD DEVIATIONS FOR NORMALIZED DATA BY MONTH

MONTHLY AVERAGE BY FISCAL YEAR	SALES	COLLECT-TIONS	OBLIGA-TIONS	DELIVERIES	DISB-MENTS	OUTLAYS
FY83	141.4	144.8	149.9	148.8	151.1	13.6
FY84	153.1	154.8	183.1	142.7	133.2	-14.0
FY85	137.1	138.7	142.1	135.9	134.6	-4.1
FY86	113.5	109.8	143.8	141.2	144.7	34.9
FY87	120.2	120.3	127.2	147.7	148.5	28.2
FY88	113.2	109.3	107.0	135.3	139.7	30.4
FY83-88	131.2	131.5	145.4	142.5	142.2	13.4
MONTHLY STANDARD DEVIATION BY FISCAL YEAR						
FY83	12.1	29.3	54.2	50.2	14.9	35.5
FY84	18.8	20.6	143.9	25.7	15.2	13.7
FY85	23.8	20.4	95.0	46.9	8.8	19.3
FY86	12.2	9.4	82.0	28.6	16.0	19.9
FY87	12.7	16.6	44.6	19.4	23.5	25.2
FY88	14.2	7.6	31.7	39.8	14.5	8.5
FY83-88	21.7	25.5	86.9	35.5	17.1	28.9

TABLE 2-2

AVERAGES AND STANDARD DEVIATIONS FOR NORMALIZED DATA BY QUARTER

QUARTERLY AVERAGE BY FISCAL YEAR

	SALES	COLLECT-TIONS	OBLIGA-TIONS	DELIVERIES	DISB-MENTS	OUTLAYS
FY83	424.2	434.3	449.8	446.3	453.2	40.7
FY84	459.2	464.5	549.3	428.2	399.6	-42.1
FY85	411.2	416.2	426.3	407.6	403.7	-12.4
FY86	340.5	329.3	431.3	423.6	434.1	104.7
FY87	360.6	360.9	381.6	443.2	445.5	84.6
FY88	339.7	327.9	320.9	405.8	419.0	91.1
FY83-88	393.7	394.4	436.1	427.6	426.5	40.2

QUARTERLY STANDARD DEVIATION BY FISCAL YEAR

	SALES	COLLECT-TIONS	OBLIGA-TIONS	DELIVERIES	DISB-MENTS	OUTLAYS
FY83	11.0	36.7	99.1	26.3	35.6	47.1
FY84	29.0	18.1	370.9	23.2	33.7	15.4
FY85	32.2	45.9	270.3	52.7	14.2	33.1
FY86	21.5	17.4	182.3	35.4	22.7	19.7
FY87	14.7	22.9	71.1	33.9	8.4	21.8
FY88	25.4	12.0	32.5	40.3	1.1	13.0
FY83-88	49.9	58.3	213.2	34.9	31.1	62.5

TABLE 3

AVERAGES AND STANDARD DEVIATIONS FOR NORMALIZED DATA BY 1st, 2nd, 3rd, and 4th QUARTERS

SALES AVERAGE

	1ST QTR	2ND QTR	3RD QTR	4TH QTR
FY83	410.1	436.7	423.3	426.8
FY84	447.8	495.0	467.1	426.7
FY85	380.2	390.6	422.9	451.0
FY86	366.5	341.9	313.9	339.5
FY87	345.5	354.0	379.9	362.9
FY88	357.6	321.7		
AVERAGE				
FY83-88	384.6	390.0	401.4	401.4
STANDARD DEVIATION				
FY83-88	38.1	65.5	57.8	47.6

COLLECTIONS AVERAGE

	1ST QTR	2ND QTR	3RD QTR	4TH QTR
FY83	411.9	399.2	444.7	481.3
FY84	441.1	480.3	459.5	477.0
FY85	368.3	388.0	440.9	467.4
FY86	335.3	329.4	319.1	333.4
FY87	332.0	369.9	355.6	386.0
FY88	336.3	319.4		
AVERAGE				
FY83-88	370.8	381.0	404.0	429.0
STANDARD DEVIATION				
FY83-88	46.0	58.0	62.5	66.1

OBLIGATIONS AVERAGE

	1ST QTR	2ND QTR	3RD QTR	4TH QTR
FY83	344.4	410.3	466.1	578.4
FY84	330.5	380.9	381.3	1104.5
FY85	137.2	338.7	445.9	783.4
FY86	260.9	272.7	398.2	793.5
FY87	358.2	323.4	359.5	485.3
FY88	343.9	297.9		
AVERAGE				
FY83-88	295.9	337.3	410.2	749.0
STANDARD DEVIATION				
FY83-88	85.0	51.3	44.6	238.8

TABLE 3 CONTINUED

DELIVERIES AVERAGE

	1ST QTR	2ND QTR	3RD QTR	4TH QTR
FY83	417.9	447.8	481.0	438.3
FY84	400.3	434.8	421.9	455.7
FY85	337.3	412.9	414.8	465.2
FY86	398.9	425.0	470.8	399.7
FY87	418.4	491.0	419.8	443.6
FY88	434.3	377.3		
AVERAGE FY83-88	401.2	431.5	441.7	440.5
STANDARD DEVIATION FY83-88	33.9	37.8	31.6	25.1

DISBURSEMENTS AVERAGE

	1ST QTR	2ND QTR	3RD QTR	4TH QTR
FY83	494.7	444.6	463.8	409.8
FY84	414.9	417.3	417.1	349.0
FY85	393.0	394.3	403.9	423.7
FY86	469.9	404.2	416.3	445.8
FY87	436.0	452.4	452.6	440.8
FY88	418.2	419.8		
AVERAGE FY83-88	437.8	422.1	430.7	413.8
STANDARD DEVIATION FY83-88	37.9	22.6	25.9	38.9

OUTLAYS AVERAGE

	1ST QTR	2ND QTR	3RD QTR	4TH QTR
FY83	82.7	76.5	19.2	-15.5
FY84	-26.1	-62.8	-42.5	-37.1
FY85	24.6	6.2	-36.8	-43.7
FY86	134.6	74.6	112.4	112.4
FY87	104.1	82.5	97.0	54.8
FY88	81.9	100.3		
AVERAGE FY83-88	67.0	46.2	29.9	14.2
STANDARD DEVIATION FY83-88	58.1	62.4	72.7	67.4

Results of Regression

In order to build a regression model that would be useful to forecast outlays, the concept of lagging variables became important. As stated in the methodology it is assumed that there is a time lag relationship between the variables. In order to develop a regression model to predict outlays, one must first estimate the parameters for the independent variables. The most logical variable is obligations, as the majority of outlays should occur approximately 12-13 months after the obligation (14). Also, if other variables were shown to be significantly correlated with obligations, that could provide a useful tool. This is due to the assumption that outlays will be affected based on the variables listed in the Chapter II, the Variable Identification and Specification section. Quarterly normalized data was used.

Obligations were lagged from one to six quarters (the six quarter lag would represent 15 to 18 months in the past). Results of the matrix are listed below. A copy of the program is contained in Appendix D. Only positive R values would fit the proper variable specifications.

	OUTLAYS	DELIVERIES	DISBURSEMENTS	COLLECTIONS
OBLIGATIONS				
LAGGED 1 QTR	-.335	-.534	.069	-.135
LAGGED 2 QTRS	.028	.027	-.121	-.117
LAGGED 3 QTRS	-.100	.025	-.048	.022
LAGGED 4 QTRS	-.320	.322	-.078	.374
LAGGED 5 QTRS	.322	-.301	.272	-.227
LAGGED 6 QTRS	.127	-.008	-.128	-.236

Although none of the individual variables explained a significant proportion of the variability in outlays, it was hoped that a multivariate model might still provide satisfactory results.

Forward, backward, and stepwise regressions in SAS were run on outlays, disbursements and deliveries as dependent variables and obligations lagged from one to six quarters as the independent variable. The SAS program file is contained in Appendix E. The dependent variables were selected based upon their logical relationship to obligations, as discussed earlier.

No model explained over 40% of the variation in outlays. At this point the use of a regression model for forecasting was deemed to be unsatisfactory.

Results of Univariate Time Series Models

Univariate time series models were then run on quarterly normalized data for outlays, disbursements, sales, deliveries, and collections. Table 4 through 8 compares the three models' accuracy measures of model fitting. Holt is displayed without considering seasonality and with seasonality. Holt (S) indicates seasonality was considered. The table also contains the quarterly forecasts for each model.

TABLE 4

CENSUS II, HOLT, AND WINTERS DATA COMPARISON (DOLLARS IN MILLIONS)

OUTLAYS

ACCURACY MEASURES OF MODEL FITTING

	MPE	MAPE	MAD	RMSE	THEIL'S U	TIME SERIES R SQUARE
CENSUS	XXXX	XXXX	14.09	20.80	0.40	0.89
HOLT	XXXX	XXXX	30.11	48.29	0.99	0.47
HOLT(S)	XXXX	XXXX	32.02	42.16	0.87	0.54
WINTERS	XXXX	XXXX	32.70	47.65	0.97	0.51

SIX QTR FORECAST

	FY88		FY89			
	3RD QTR	4TH QTR	1ST QTR	2ND QTR	3RD QTR	4TH QTR
CENSUS	81.81	68.17	157.27	118.87	100.38	84.91
HOLT	92.57	91.23	89.88	88.54	87.20	85.85
HOLT(S)	87.85	72.88	135.95	115.24	106.55	89.68
WINTERS	96.23	63.03	113.79	110.93	110.68	74.82

Census II provides the best fit of the historical data based on the smallest MAD and RMSE. As discussed later in this chapter, the MPE and MAPE are not appropriate in this discussion as a constant was added to outlays to eliminate any negative data used by Census II. The time series R squared of .89 indicates that Census II explained 89% of the variation in the normalized historical data using its algorithms for the trend, cycle, and seasonality.

The forecasts range from a low of $68.17 million in the 4th quarter of FY 88 to a high of $157.27 million in the 1st quarter of FY 89. More detailed analysis of the Census II outlay model will follow later in this chapter.

TABLE 5

CENSUS II, HOLT, AND WINTERS DATA COMPARISON

(DOLLARS IN MILLIONS)

DISBURSEMENTS

ACCURACY MEASURES OF MODEL FITTING

	MPE	MAPE	MAD	RMSE	THEIL'S U	TIMES SERIES R SQUARE
CENSUS	-0.11	2.66	10.79	12.86	0.41	0.83
HOLT	0.62	5.86	23.68	28.90	0.92	0.35
HOLT(S)	0.63	5.48	22.22	27.92	0.89	0.37
WINTERS	1.00	5.29	20.36	28.84	0.86	0.25

SIX QTR FORECAST

	FY88		FY89			
	3RD QTR	4TH QTR	1ST QTR	2ND QTR	3RD QTR	4TH QTR
CENSUS	431.55	415.54	435.06	420.80	431.33	415.32
HOLT	416.53	405.33	394.13	382.93	371.73	360.53
HOLT(S)	425.11	403.33	399.92	383.57	383.54	362.90
WINTERS	430.72	417.53	422.86	416.74	427.50	414.40

Census II accuracy measures of model fitting are again favored for disbursements. The MPE, MAPE, and MAD are all relatively small. The times series R squared of .83 is also quite good.

Census II generally forecasts higher disbursements than the other models with the exception of the 4th quarter of FY 88 when the Winters model provides a slightly higher forecast.

TABLE 6

CENSUS II, HOLT, AND WINTERS DATA COMPARISON

(DOLLARS IN MILLIONS)

DELIVERIES

ACCURACY MEASURES OF MODEL FITTING

	MPE	MAPE	MAD	RMSE	THEIL'S U	TIMES SERIES R SQUARE
CENSUS	-0.10	4.16	17.48	21.40	0.42	0.62
HOLT	-1.36	6.70	26.47	38.44	0.75	0.02
HOLT(S)	-0.48	6.18	25.97	33.84	0.67	0.00
WINTERS	0.05	6.68	27.68	35.16	0.69	0.06

SIX QTR FORECAST

	FY88		FY89			
	3RD QTR	4TH QTR	1ST QTR	2ND QTR	3RD QTR	4TH QTR
CENSUS	435.22	436.16	394.67	424.59	433.66	434.60
HOLT	415.50	415.29	415.08	414.87	414.66	414.45
HOLT(S)	427.37	434.03	398.11	420.82	428.19	434.86
WINTERS	431.79	440.99	406.09	401.04	432.66	441.88

Census II remains the best overall forecaster of deliveries, but does not appear to fit the historical data as well as it did for outlays and disbursements. The times series R square is only .62 for Census II and almost non-existent for the other methods.

Census II again forecasted on the higher side compared to the other models. Census II forecasts increase from the 1st through the 4th quarter, with a mild increase from the 3rd to the 4th quarter.

TABLE 7

CENSUS II, HOLT AND WINTERS DATA COMPARISON

(DOLLARS IN MILLIONS)

COLLECTIONS

ACCURACY MEASURES OF MODEL FITTING

	MPE	MAPE	MAD	RMSE	THEIL'S U	TIMES SERIES R SQUARE
CENSUS	0.07	3.87	14.39	17.79	0.38	0.91
HOLT	-1.45	10.15	37.81	44.58	0.96	0.39
HOLT(S)	0.81	6.12	23.43	30.47	0.66	0.69
WINTERS	-1.34	7.13	27.02	33.20	0.72	0.74

SIX QTR FORECAST

	FY88		FY89			
	3RD QTR	4TH QTR	1ST QTR	2ND QTR	3RD QTR	4TH QTR
CENSUS	325.35	342.75	289.68	293.34	299.91	315.43
HOLT	322.97	316.70	310.42	304.15	297.87	291.60
HOLT(S)	318.67	334.98	284.02	286.62	285.04	298.67
WINTERS	331.85	358.29	301.89	302.54	313.99	338.75

Census II accuracy measures of model fitting for collections are the best thus far in the analysis. Census II model fitting statistics are significantly better that the other methods. The times series R square is the highest for all variables tested.

The Winters method provides the highest forecast for collections generally followed by Census II.

TABLE 8

CENSUS II, HOLT, AND WINTERS DATA COMPARISON

(DOLLARS IN MILLIONS)

SALES

ACCURACY MEASURES OF MODEL FITTING

	MPE	MAPE	MAD	RMSE	THEIL'S U	TIMES SERIES R SQUARE
CENSUS	-0.30	3.74	14.84	18.55	0.59	0.86
HOLT	-0.57	7.20	26.65	33.12	1.03	0.60
HOLT(S)	-0.37	7.24	27.06	31.93	1.00	0.61
WINTERS	-1.66	7.78	28.66	37.00	1.16	0.46

SIX QTR FORECAST

	FY88		FY89			
	3RD QTR	4TH QTR	1ST QTR	2ND QTR	3RD QTR	4TH QTR
CENSUS	331.40	329.44	308.99	307.95	308.29	306.05
HOLT	315.46	309.18	302.89	296.61	290.32	284.04
HOLT(S)	322.66	311.43	297.52	295.79	296.08	285.23
WINTERS	334.04	329.52	309.49	302.84	309.96	305.34

Census again provides the best model fitting in the last variable tested, sales. All statistics favor Census II, including a fairly high times series R square of .86.

All the forecasts for FY 89 have a small range, in particular Census II forecasts a constant sales rate between $306 and $309 million.

In all cases Census II provided the best model fit to the variables. The time series R square was above .80 for all variables except deliveries. In particular, the time series R square for outlays of .89 with other reasonable statistics was encouraging.

Detailed Census II Analysis for Outlays. Appendix F contains the Census II output file for outlays used in this analysis. It is important to note that the quarterly outlays listed on the printout are increased by $100 million. Due to some quarters being negative, a $100 million constant was added to all data entries for outlays. Census II is not able to use data sets with negative numbers; the program gives you the option of adding a constant to eliminate negative entries. All outlay time series analyses used the same data set with the $100 million added to each quarterly figure. Quarterly figures quoted in this chapter have the constant subtracted back out. The constant only affected the computation of the MPE and MAPE--understating them by some unknown amount; they were thus not reported for outlays. Also, the printout lists quarters by calendar year. Therefore, when the printout lists the last quarter of calendar year 1982, this should be interpreted as the first quarter of fiscal year 1983.

A brief summary of the Census II results follow (see Appendix F for additional details). The Stable Factors - Seasonal Indices table lists indices for each quarter. These

indices may be thought of as percentages of the average for the year. Stable factors exclude extreme values and are based on averages for the same quarter (i.e., all 1st, 2nd, etc.) (18:216). The stable factors -seasonal quarterly indices for all years were:

1st QTR	2nd QTR	3rd QTR	4th QTR
102.44	91.61	82.62	123.33

These seasonal factors indicate that based on the stable factor - seasonal index the 3rd quarter would be 82.62% of the average, while the 4th quarter is 23.33% greater than the average. Census II computed the overall average annual growth of outlays based on the original data to be 10.35%.

As a test of reasonableness, no data was collected after the 2nd quarter of FY 88. After the models were built, a meeting with the HQ AFLC SSD Budget Analyst was held. At the meeting the 3rd quarter of FY 88 actuals were made available as well as HQ AFLC'S forecasts using actual data also through the 2nd quarter of FY 88 (6). The results of this comparison are shown in Table 9.

TABLE 9

HQ AFLC AND CENSUS II FORECAST

TO ACTUAL COMPARISON 3RD QTR FY88

(DOLLARS IN MILLIONS)

	OUTLAYS	DISBUR-SEMENTS	DELIV-ERIES	COLLEC-TIONS	SALES
ACTUAL DATA	82.80	411.30	451.80	328.50	310.10
HQ AFLC FORECAST	110.20	442.40	67.90	332.20	318.65
DIFFERENCE	-27.40	-31.10	-16.10	-3.70	8.55
%ERROR FROM ACTUAL	-0.33	-0.08	-0.04	-0.01	-0.03
ACTUAL DATA	82.80	411.30	451.80	328.50	310.10
CENSUS FORECAST	81.80	431.60	435.22	325.40	331.40
DIFFERENCE	1.00	-20.30	16.58	3.10	21.3
%ERROR FROM ACTUAL	0.01	-0.05	0.04	0.01	-0.07

Census II was particularly accurate at forecasting outlays for the 3rd quarter of FY 88. Census II forecasted within 1% or $ 1 million, while HQ AFLC's estimate was overstated by 33% or $27.4 million. Census II was slightly better than the HQ AFLC'S estimate for disbursements and about the same level of accuracy for deliveries, and collections. HQ AFLC was slightly better at forecasting sales.

Summary

While these results appear quite promising and indicate that time series techniques may have value for improved forecasting of SSD outlays. In particular, the Census II technique demonstrated excellent fitting ability and, for the most recent quarter, a superior forecasting ability. However, more research is required. Each quarterly forecast's accuracy is really independent of the previous quarter. As stated, Census II shows promise but as indicated in the literature review, no forecasting method guarantees future results.

V. Conclusions and Recommendations

Conclusions

This study was undertaken in response to the AFLC Comptroller's interest in improving outlay forecasts for the SSD portion of the USAF Stock Fund. The need to improve outlay forecasts is driven by the overall government need to manage outlays, due to the growing emphasis on controlling the annual deficit. A variety of financial controls imposed by Congress make it difficult for executive agencies, such as the Air Force, to significantly change outlays in the short-term. The current financial controls imposed by Congress are unlikely to change. Therefore, the literature suggests improved outlay forecasting methods at the sub-appropriation level to begin the long-term task of managing outlays.

SSD outlays are an excellent area of study as they represent actual disbursement from the Treasury and have consistently been difficult to accurately forecast. The information gathered on forecasting methods suggested that basic statistics, graphing, regression, and time-series techniques might provide the answer to improved outlay forecasts.

The best technique for forecasting SSD outlays in this paper was Census II. Census II is a decomposition time-series technique which uses historical data to determine the seasonality, trend, and cycle with a factor for

randomness. Census II was able to forecast to within one million dollars (or one percent) of the actual SSD outlays for the 3rd Quarter of FY 88. This was a significant improvement from HQ AFLC's estimate, which overestimated outlays by $27.4 million (or 33%).

As with all forecasting techniques, there are no guarantees that a model that fits historical data well will actually do a good job of forecasting the future. It is also true that a model that forecast accurately once in the future may not have a high degree of accuracy for subsequent periods. Thus, the level of accuracy attained in forecasting the 3rd quarter of FY 88 should not be expected to necessarily continue. However, these positive results do hold promise for the possibility of improved outlay forecasts in the SSD.

It might also be possible that the underlying patterns of the various variables will lend themselves to different forecasting techniques (i.e. Census II was the best predictor of outlays, collections, and deliveries, but Holt provided better forecasts for disbursements and sales). With sufficient data, a series of techniques may be selected to forecast each of the variables. It is also advisable to at least use two techniques, one for forecast and a second to check reasonableness.

RECOMMENDATIONS

1. Recommend that the normalized quarterly variable data base be transferred and maintained by the HQ AFLC Comptroller organization.

2. Recommend that the Census II and other time-series forecasting methods such as Holt and Winters be used to further test their ability to forecast SSD outlays. These forecasts could be used in conjunction with current AFLC practices. Once the data base is established, the actual operator and computer time required to accomplish forecasts is less than thirty minutes. If the various time series techniques do not provide accurate forecasts, more data analysis may be required of SSD outlays at the next sub-category level of SSD funds management: hardware; provisioning; inventory augmentation; and War Reserve Material. Obtaining accurate accounting information at this level may be time consuming and may not justify the improved accuracy.

4. Recommend that time-series techniques, such as those used in this study, be tested for their ability to forecast other sub-appropriations (i.e. 3010, 3020 or 3080).

APPENDIX A

RAW DATA: MONTHLY NON-CUMULATIVE

		SALES	COLLECT-TIONS	OBLIGA-TIONS	DELIVERIES	DISB-MENTS	OUTLAYS
FY83	OCT	138.2	107.0	116.7	100.8	165.4	58.4
	NOV	150.0	141.8	115.6	158.0	157.1	15.2
	DEC	121.9	163.1	112.1	159.1	172.2	9.1
	JAN	139.2	110.1	108.0	177.3	163.5	53.5
	FEB	137.5	132.1	151.2	131.4	132.1	31.0
	MAR	160.0	157.0	151.1	139.1	149.0	-8.0
	APR	156.1	122.6	145.0	215.8	156.4	33.8
	MAY	133.1	174.1	155.9	165.7	150.5	-23.5
	JUN	134.1	148.0	165.2	99.5	156.9	8.9
	JUL	130.6	134.7	129.6	239.1	121.6	-13.1
	AUG	137.2	212.3	137.8	143.0	153.9	-58.4
	SEP	159.0	134.3	311.0	56.2	134.3	56.0
FY84	OCT	151.7	123.7	143.6	-220.3	122.7	-1.1
	NOV	149.6	183.4	113.4	188.6	156.4	-26.9
	DEC	146.5	134.0	73.5	121.8	135.8	1.9
	JAN	162.2	139.5	142.4	153.8	134.6	-4.8
	FEB	161.5	176.1	116.3	146.6	143.7	-32.3
	MAR	171.3	164.7	122.2	134.4	139.0	-25.7
	APR	161.1	171.9	142.7	156.1	148.1	-23.8
	MAY	154.3	139.2	77.8	122.9	142.5	3.3
	JUN	151.7	148.4	160.8	142.9	126.5	-22.0
	JUL	120.0	146.0	196.4	141.6	103.5	2.9
	AUG	157.4	152.4	313.6	137.8	134.7	27.7
	SEP	103.9	133.2	594.5	176.3	110.8	-22.3
FY85	OCT	138.2	128.9	42.0	20.3	128.5	-.4
	NOV	125.8	100.2	54.2	154.8	137.2	37.0
	DEC	116.2	139.2	41.0	162.2	127.3	-12.0
	JAN	116.3	149.0	104.9	132.6	133.8	-15.2
	FEB	122.6	118.9	81.0	110.2	132.5	13.5
	MAR	-22.2	-53.8	152.8	170.1	128.0	181.8
	APR	140.1	148.2	145.2	128.6	143.2	-4.9
	MAY	184.0	144.3	139.9	143.3	134.3	-9.9
	JUN	98.8	148.4	160.8	142.9	126.4	-22.0
	JUL	155.5	159.1	146.5	220.8	158.0	-1.2
	AUG	164.6	131.3	276.1	112.7	130.2	-1.1

APPENDIX A CONTINUED

	SEP	130.9	177.0	360.8	131.7	135.5	-41.4
FY86	OCT	146.8	118.0	104.0	114.8	161.0	43.0
	NOV	117.3	102.5	47.7	262.5	142.5	40.0
	DEC	102.4	114.8	109.2	86.6	166.4	51.6
	JAN	-93.3	-92.0	79.5	55.3	120.7	212.6
	FEB	110.2	88.4	91.2	243.1	148.4	59.9
	MAR	112.3	120.3	102.0	61.5	135.1	14.8
	APR	18.4	18.3	130.2	171.4	155.4	137.1
	MAY	97.8	113.2	114.9	125.4	129.1	15.9
	JUN	10.4	100.3	153.1	174.0	131.8	31.5
	JUL	114.9	112.7	193.6	178.9	141.8	29.1
	AUG	108.9	113.4	279.1	113.9	132.7	19.3
	SEP	115.7	107.3	320.8	106.9	171.3	64.0
FY87	OCT	134.2	95.1	137.5	130.4	145.9	50.8
	NOV	118.2	139.4	54.0	131.9	121.6	-17.7
	DEC	93.1	97.5	166.7	156.1	168.5	71.0
	JAN	106.1	130.3	102.0	175.1	141.6	11.3
	FEB	118.4	100.6	99.0	126.1	110.0	9.4
	MAR	129.5	139.0	122.4	189.8	200.8	61.8
	APR	133.8	123.1	108.9	151.5	157.6	34.5
	MAY	118.9	107.1	111.0	137.4	131.4	24.3
	JUN	127.2	125.4	139.6	130.9	163.6	38.2
	JUL	-137.3	-142.2	97.4	153.3	153.1	295.3
	AUG	107.5	118.0	156.3	151.4	143.8	25.8
	SEP	122.7	140.2	231.6	138.9	143.9	3.7
FY88	OCT	126.1	108.8	148.3	198.0	134.1	25.3
	NOV	108.6	103.6	64.7	87.7	122.1	18.5
	DEC	122.9	123.9	130.9	148.6	162.0	38.1
	JAN	114.1	103.1	87.1	121.7	132.6	29.5
	FEB	87.3	106.5	88.7	102.8	135.7	29.1
	MAR	120.3	109.8	122.1	152.8	151.5	41.7

APPENDIX B

NORMALIZED DATA: MONTHLY NON-CUMULATIVE

		SALES	COLLECT-TIONS	OBLIGA-TIONS	DELIVERIES	DISB-MENTS	OUTLAYS
FY83	OCT	138.2	107.0	116.7	100.8	165.4	58.4
	NOV	150.0	141.8	115.6	158.0	157.1	15.2
	DEC	121.9	163.1	112.1	159.1	172.2	9.1
	JAN	139.2	110.1	108.0	177.3	163.5	53.5
	FEB	137.5	132.1	151.2	131.4	132.1	31.0
	MAR	160.0	157.0	151.1	139.1	149.0	-8.0
	APR	156.1	122.6	145.0	215.8	156.4	33.8
	MAY	133.1	174.1	155.9	165.7	150.5	-23.5
	JUN	134.1	148.0	165.2	99.5	156.9	8.9
	JUL	130.6	134.7	129.6	239.1	121.6	-13.1
	AUG	137.2	212.3	137.8	143.0	153.9	-58.4
	SEP	159.0	134.3	311.0	56.2	134.3	56.0
FY84	OCT	151.7	123.7	143.6	89.9	122.7	-1.1
	NOV	149.6	183.4	113.4	188.6	156.4	-26.9
	DEC	146.5	134.0	73.5	121.8	135.8	1.9
	JAN	162.2	139.5	142.4	153.8	134.6	-4.8
	FEB	161.5	176.1	116.3	146.6	143.7	-32.3
	MAR	171.3	164.7	122.2	134.4	139.0	-25.7
	APR	161.1	171.9	142.7	156.1	148.1	-23.8
	MAY	154.3	139.2	77.8	122.9	142.5	3.3
	JUN	151.7	148.4	160.8	142.9	126.5	-22.0
	JUL	142.7	168.7	196.4	141.6	103.5	-19.8
	AUG	180.1	175.1	313.6	137.8	134.7	5.0
	SEP	103.9	133.2	594.5	176.3	110.8	-22.3
FY85	OCT	138.2	128.9	42.0	20.3	128.5	-.4
	NOV	125.8	100.2	54.2	154.8	137.2	37.0
	DEC	116.2	139.2	41.0	162.2	127.3	-12.0
	JAN	116.3	149.0	104.9	132.6	133.8	-15.2
	FEB	122.6	118.9	81.0	110.2	132.5	13.5
	MAR	151.7	120.1	152.8	170.1	128.0	7.9
	APR	140.1	148.2	145.2	128.6	143.2	-4.9
	MAY	184.0	144.3	139.9	143.3	134.3	-9.9
	JUN	98.8	148.4	160.8	142.9	126.4	-22.0
	JUL	155.5	159.1	146.5	220.8	158.0	-1.2
	AUG	164.6	131.3	276.1	112.7	130.2	-1.1
	SEP	130.9	177.0	360.8	131.7	135.5	-41.4

APPENDIX B CONTINUED

		SALES	COLLEC-TIONS	OBLIGA-TIONS	DELIVERES	DISB-MENT	OUTLAYS
FY86	OCT	146.8	118.0	104.0	114.8	161.0	43.0
	NOV	117.3	102.5	47.7	162.5	142.5	40.0
	DEC	102.4	114.8	109.2	121.6	166.4	51.6
	JAN	119.4	120.7	79.5	120.3	120.7	-.1
	FEB	110.2	88.4	91.2	128.1	148.4	59.9
	MAR	112.3	120.3	102.0	176.6	135.1	14.8
	APR	105.7	105.6	130.2	171.4	155.4	49.8
	MAY	97.8	113.2	114.9	125.4	129.1	15.9
	JUN	110.4	100.3	153.1	174.0	131.8	31.5
	JUL	114.9	112.7	193.6	178.9	141.8	29.1
	AUG	108.9	113.4	279.1	113.9	132.7	19.3
	SEP	115.7	107.3	320.8	106.9	171.3	64.0
FY87	OCT	134.2	95.1	137.5	130.4	145.9	50.8
	NOV	118.2	139.4	54.0	131.9	121.6	-17.7
	DEC	93.1	97.5	166.7	156.1	168.5	71.0
	JAN	106.1	130.3	102.0	175.1	141.6	11.3
	FEB	118.4	100.6	99.0	126.1	110.0	9.4
	MAR	129.5	139.0	122.4	189.8	200.8	61.8
	APR	133.8	123.1	108.9	151.5	157.6	34.5
	MAY	118.9	107.1	111.0	137.4	131.4	24.3
	JUN	127.2	125.4	139.6	130.9	163.6	38.2
	JUL	132.7	127.8	97.4	153.3	153.1	25.3
	AUG	107.5	118.0	156.3	151.4	143.8	25.8
	SEP	122.7	140.2	231.6	138.9	143.9	3.7
FY88	OCT	126.1	108.8	148.3	198.0	134.1	25.3
	NOV	108.6	103.6	64.7	87.7	122.1	18.5
	DEC	122.9	123.9	130.9	148.6	162.0	38.1
	JAN	114.1	103.1	87.1	121.7	132.6	29.5
	FEB	87.3	106.5	88.7	102.8	135.7	29.1
	MAR	120.3	109.8	122.1	152.8	151.5	41.7

Normalization procedures.

1. Refunds that were subtracted from outlays and added back to collections and sales.

FY	Month	Amount in Millions
84	Jul	22.7
84	Aug	22.7
85	Mar	173.9
86	Jan	212.7
86	Apr	87.3
87	Jul	270.0

2. Accounting errors when reporting deliveries. The FY, month, and amount of adjustment are shown below. Also, deliveries for FY 83 Apr and Jul are believed to be incorrect, but no documentation is available to normalize these months.

FY	Month	Amount in Millions
84	Oct	310.2
86	Nov	(100.0)
86	Dec	35.0
86	Jan	65.0
86	Feb	(115.0)
86	Mar	115.0

APPENDIX C

AVERAGES AND STANDARD DEVIATIONS ORGANIZED BY MONTH
(NORMALIZED DATA: MONTHLY NON-CUMULATIVE)

SALES AVERAGE

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
FY83	138.2	150.0	121.9	139.2	137.5	160.0	156.1	133.1	134.1	130.6	137.2	159.0
FY84	151.7	149.6	146.5	162.2	161.5	171.3	161.1	154.3	151.7	142.7	180.1	103.9
FY85	138.2	125.8	116.2	116.3	122.6	151.7	140.1	184.0	98.8	155.5	164.6	130.9
FY86	146.8	117.3	102.4	119.4	110.2	112.3	105.7	97.8	110.4	114.9	108.9	115.7
FY87	134.2	118.2	93.1	106.1	118.4	129.5	133.8	118.9	127.2	132.7	107.5	122.7
FY88	126.1	108.6	122.9	114.1	87.3	120.3						
AVERAGE												
FY83	139.2	128.3	117.2	126.2	122.9	140.9	139.4	137.6	124.4	135.3	139.7	126.4
STANDARD DEVIATION												
FY83	9.1	17.6	18.5	20.8	25.1	23.6	21.9	33.1	20.6	15.1	32.6	20.7

COLLECTIONS AVERAGE

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
FY83	107.0	141.8	163.1	110.1	132.1	157.0	122.6	174.1	148.0	134.7	212.3	134.3
FY84	123.7	183.4	134.0	139.5	176.1	164.7	171.9	139.2	148.4	168.7	175.1	133.2
FY85	128.9	100.2	139.2	149.0	118.9	120.1	148.2	144.3	148.4	159.1	131.3	177.0
FY86	118.0	102.5	114.8	120.7	88.4	120.3	105.6	113.2	100.3	112.7	113.4	107.3
FY87	95.1	139.4	97.5	130.3	100.6	139.0	123.1	107.1	125.4	127.8	118.0	140.2
FY88	108.8	103.6	123.9	103.1	106.5	109.8						
AVERAGE												
FY83	113.6	128.5	128.8	125.5	120.4	135.2	134.3	135.6	134.1	140.6	150.0	138.4
STANDARD DEVIATION												
FY83	12.4	32.9	22.4	17.5	31.1	22.2	25.9	26.9	21.3	23.0	42.5	25.0

OBLIGATIONS AVERAGE

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
FY83	116.7	115.6	112.1	108.0	151.2	151.1	145.0	155.9	165.2	129.6	137.8	311.0
FY84	143.6	113.4	73.5	142.4	116.3	122.2	142.7	77.8	160.8	196.4	313.6	594.5
FY85	42.0	54.2	41.0	104.9	81.0	152.8	145.2	139.9	160.8	146.5	276.1	360.8
FY86	104.0	47.7	109.2	79.5	91.2	102.0	130.2	114.9	153.1	193.6	279.1	320.8
FY87	137.5	54.0	166.7	102.0	99.0	122.4	108.9	111.0	139.6	97.4	156.3	231.6
FY88	148.3	64.7	130.9	87.1	88.7	122.1						
AVERAGE												
FY83	115.4	74.9	105.6	104.0	104.6	128.8	134.4	119.9	155.9	152.7	232.6	363.7
STANDARD DEVIATION												
FY83	39.7	31.1	43.9	21.8	25.8	19.6	15.5	29.9	10.1	42.5	79.7	137.2

DELIVERIES AVERAGE

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
	100.8	158.0	159.1	177.3	131.4	139.1	215.8	165.7	99.5	239.1	143.0	56.2
	89.9	188.6	121.8	153.8	146.6	134.4	156.1	122.9	142.9	141.6	137.8	176.3
	20.3	154.8	162.2	132.6	110.2	170.1	128.6	143.3	142.9	220.8	112.7	131.7
	114.8	162.5	121.6	120.3	128.1	176.6	171.4	125.4	174.0	178.9	113.9	106.9
	130.4	131.9	156.1	175.1	126.1	189.8	151.5	137.4	130.9	153.3	151.4	138.9
	198.0	87.7	148.6	121.7	102.8	152.8						
AVERAGE FY	109.0	147.3	144.9	146.8	124.2	160.5	164.7	138.9	138.0	186.7	131.8	122.0
STANDARD DEVIATION FY	57.8	34.3	18.5	25.7	15.7	21.9	32.4	17.2	26.8	42.2	17.5	44.4

DISBURSEMENTS AVERAGE

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
	165.4	157.1	172.2	163.5	132.1	149.0	156.4	150.5	156.9	121.6	153.9	134.3
	122.7	156.4	135.8	134.6	143.7	139.0	148.1	142.5	126.5	103.5	134.7	110.8
	128.5	137.2	127.3	133.8	132.5	128.0	143.2	134.3	126.4	158.0	130.2	135.5
	161.0	142.5	166.4	120.7	148.4	135.1	155.4	129.1	131.8	141.8	132.7	171.3
	145.9	121.6	168.5	141.6	110.0	200.8	157.6	131.4	163.6	153.1	143.8	143.9
	134.1	122.1	162.0	132.6	135.7	151.5						
AVERAGE FY	142.9	139.5	155.4	137.8	133.7	150.6	152.1	137.6	141.0	135.6	139.1	139.2
STANDARD DEVIATION FY	17.5	15.7	18.9	14.3	13.3	26.1	6.2	8.8	17.8	22.8	9.8	21.8

OUTLAYS AVERAGE

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
	58.4	15.2	9.1	53.5	31.0	-8.0	33.8	-23.5	8.9	-13.1	-58.4	56.0
	-1.1	-26.9	1.9	-4.8	-32.3	-25.7	-23.8	3.3	-22.0	-19.8	5.0	-22.3
	-.4	37.0	-12.0	-15.2	13.5	7.9	-4.9	-9.9	-22.0	-1.2	-1.1	-41.4
	43.0	40.0	51.6	-.1	59.9	14.8	49.8	15.9	31.5	29.1	19.3	64.0
	50.8	-17.7	71.0	11.3	9.4	61.8	34.5	24.3	38.2	25.3	25.8	3.7
	25.3	18.5	38.1	29.5	29.1	41.7						
AVERAGE FY	29.3	11.0	26.6	12.4	18.4	15.4	17.9	2.0	6.9	4.1	-1.9	12.0
STANDARD DEVIATION FY	25.8	27.8	32.0	25.3	30.6	32.1	30.8	19.3	28.5	22.2	33.4	46.7

APPENDIX D

SAS CORRELATION MATRIX PROGRAM

```
options ls = 80;
data thesisr;
infile qall;
input sales coll obl del disb out;
S1=LAG1(SALES);
S2=LAG2(SALES);
S3=LAG3(SALES);
S4=LAG4(SALES);
S5=LAG5(SALES);
S6=LAG6(SALES);
C1=LAG1(COLL);
C2=LAG2(COLL);
C3=LAG3(COLL);
C4=LAG4(COLL);
C5=LAG5(COLL);
C6=LAG6(COLL);
O1=LAG1(OBL);
O2=LAG2(OBL);
O3=LAG3(OBL);
O4=LAG4(OBL);
O5=LAG5(OBL);
O6=LAG6(OBL);
DE1=LAG1(DEL);
DE2=LAG2(DEL);
DE3=LAG3(DEL);
DE4=LAG4(DEL);
DE5=LAG5(DEL);
DE6=LAG6(DEL);
DI1=LAG1(DISB);
DI2=LAG2(DISB);
DI3=LAG3(DISB);
DI4=LAG4(DISB);
DI5=LAG5(DISB);
DI6=LAG6(DISB);
proc corr;
```

APPENDIX E

SAS PROGRAM FOR REGRESSION

```
options ls = 80;
data thesisr;
infile qall;
input sales coll obl del disb out;
O1=LAG1(OBL);
O2=LAG2(OBL);
O3=LAG3(OBL);
O4=LAG4(OBL);
O5=LAG5(OBL);
O6=LAG6(OBL);
PROC STEPWISE;
MODEL DISB=O1 O2 O3 O4 O5 O6/FORWARD DETAILS;
MODEL DISB=O1 O2 O3 O4 O5 O6/STEPWISE DETAILS;
MODEL DISB=O1 O2 O3 O4 O5 O6/BACKWARD DETAILS;
MODEL DEL=O1 O2 O3 O4 O5 O6/FORWARD DETAILS;
MODEL DEL=O1 O2 O3 O4 O5 O6/STEPWISE DETAILS;
MODEL DEL=O1 O2 O3 O4 O5 O6/BACKWARD DETAILS;
MODEL OUT=O1 O2 O3 O4 O5 O6/FORWARD DETAILS;
MODEL OUT=O1 O2 O3 O4 O5 O6/STEPWISE DETAILS;
MODEL OUT=O1 O2 O3 O4 O5 O6/BACKWARD DETAILS;
```

WHERE: QALL CONTAINS THE DATA FILE WITH ALL THE QUARTERLY VARIABLES.
OBL = QUARTERLY OBLIGATIONS
DISB = QUARTERLY DISBURSEMENTS
DEL = QUARTERLY DELIVERIES
OUT = QUARTERLY OUTLAYS

APPENDIX F

CENSUS II OUTPUT

Year	1st Qrt	2nd Qrt	3rd Qrt	4th Qrt	Total	% Growth
			Original data			
1982				182.7	182.70	0.00
1983	176.5	119.2	84.5	73.9	454.10	-37.86
1984	37.2	57.5	62.9	124.6	282.20	-37.86
1985	106.2	63.2	56.3	234.6	460.30	63.11
1986	174.6	197.2	212.4	204.1	788.30	71.26
1987	182.5	197.0	154.8	181.9	716.20	-9.15
1988	200.3				200.30	11.87
Average	146.2	126.8	114.2	167.0	440.59	10.23%

	A D J U S T M E N T S			F O R E C A S T S		
Period	Workdays	Spec.events	Others	Pessimistic	Most likely	Optimistic
1988 2nd Qrt	1.00	1.00	1.00	140.21	181.81	223.42
1988 3rd Qrt	1.00	1.00	1.00	115.76	168.17	220.57
1988 4th Qrt	1.00	1.00	1.00	197.29	257.27	317.25
Total					607.25	
1989 1st Qrt	1.00	1.00	1.00	152.86	218.87	284.89
1989 2nd Qrt	1.00	1.00	1.00	129.28	200.38	271.49
1989 3rd Qrt	1.00	1.00	1.00	109.36	184.91	260.47
Total					604.17	

A C C U R A C Y Measures of M O D E L Fitting		
Mean Percentage Error, or Bias (MPE)	=	-5.78
Mean Absolute Percentage Error (MAPE)	=	12.57
Mean Absolute Deviation (MAD)	=	14.09
Root Mean Squared Error (RMSE)	=	20.80
Theil's U-statistic (Original data)	=	0.40
Time Series R-square	=	0.89

APPENDIX F CONTINUED

Final Seasonal Factors

1982				112.6
1983	76.0	96.0	86.3	125.2
1984	81.1	90.9	83.8	137.4
1985	93.6	88.3	79.9	138.2
1986	98.5	91.6	83.1	125.4
1987	99.8	95.9	83.7	116.8
1988	96.5			

Stable Factors -Seasonal Indices-

1st Qrt	2nd Qrt	3rd Qrt	4th Qrt	Total	AVER.
102.44	91.61	82.62	123.33	400.0	100.0

Final Seasonally Adjusted Series

Year	1st Qrt	2nd Qrt	3rd Qrt	4th Qrt	Total	% Growth
1982				162.3	162.29	0.00
1983	232.2	124.1	98.0	59.0	513.28	-20.93
1984	45.9	63.3	75.1	90.7	274.87	-46.45
1985	113.5	71.6	70.4	169.8	425.30	54.73
1986	177.2	215.3	255.5	162.7	810.81	90.65
1987	182.8	205.4	185.0	155.7	728.86	-10.11
1988	207.7				207.67	13.97
Average	159.9	136.0	136.8	133.4	446.15	13.64%

Months for Critical Dominance (MCD) = 3

3 MCD Moving Average of Deseasonalized Series

Year	1st Qrt	2nd Qrt	3rd Qrt	4th Qrt	Total	% Growth
1982				177.7	177.72	0.00
1983	187.7	144.6	94.8	65.5	492.53	-30.72
1984	53.5	61.9	76.0	92.5	283.86	-42.37
1985	97.3	81.8	95.6	146.8	421.45	48.47
1986	184.9	215.8	222.3	190.9	813.95	93.13
1987	183.4	194.6	182.8	176.0	736.85	-9.47
1988	189.9				189.86	3.07
Average	149.4	139.7	134.3	141.6	445.18	10.35%

Average percentage Changes in the Time Series components

Original	Deseasonal	Random	MDC T-C	Trend-Cycl
37.61	29.50	24.44	16.74	11.14

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THESIS CHAIRMAN: ROLAND D. KANKEY, PHD.
ASSISTANT PROFESSOR OF QUANTITATIVE MANAGEMENT

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This ~~study~~ was undertaken in response to the Air Force Logistics Command Comptroller's interest in improving outlay forecasts for the System Support Division (SSD) portion of the Air Force Stock Fund. The need to improve outlay forecasts is driven by the overall government need to manage outlays, due to the growing emphasis on controlling the annual deficit. The literature suggests improving outlay forecasting methods at the sub-appropriation level to begin the long-term task of managing outlays.

The best technique for forecasting SSD outlays in this paper was the decomposition time series technique Census II. Census II was able to forecast to within one percent or one million dollars of the actual SSD outlays for the 3rd Quarter of FY 88. This was a significant improvement from HQ AFLC's estimate, which was overstated by 33% or $27.4 million.

Recommendations included that the Census II and other time-series forecasting methods, such as Holt and Winters, be used to further test their ability to forecast SSD outlays as well as other appropriations.

Approved for public release IAW AFR 190-1.

WILLIAM A. MAUER 17 Oct 88
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